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NEPONSET RIVER BASIN MASSACHUSETTS, FLOOD PLAIN MANAGEMENT STUD--ETC(U)

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Water Resources Investigation
Review Draft

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Neponset River Basin Massachusetts Flood Plain Management Study

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The Neponset Flood Plain Management Study is a Level C feasibility study. Analysis of alternative flood plain management measures during Stage 2 investigations indicated that structural protection is not economically feasible for any individual damage site. The extent of the flood plains has not changed significantly since the last major flood event in 1968.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

NEPONSET RIVER BASIN
FLOOD PLAIN MANAGEMENT STUDY

STAGE II

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SECTION 1

INTRODUCTION

SECTION 1

INTRODUCTION

A. Executive Summary

The New England River Basins Commission identified the Neponset River Basin in its 1975 Southeastern New England (SENE) Comprehensive study as an area the Corps of Engineers should consider for a comprehensive flood management program.

The SENE study had been authorized by a Congressional Resolution of 12 September 1969 to determine "... the feasibility of providing water resource improvements for flood control ... with due consideration for enhancing economic growth and quality of the environment."

A Corps reconnaissance report, Stage 1 completed in 1979 recommended more detailed Stage 2 study of the Neponset River Basin. This report presents the findings of the Stage 2 study. It details past and potential flood damage sites and formulates solutions and recommendations.

The Neponset River originates in Foxborough, Massachusetts, and flows 28 miles northeasterly into Boston Harbor. Hydrologically, the river is very sluggish. It has a very flat stream gradient and cuts through numerous swamp and floodplain areas. Over 23 tributaries contribute to the river's flow, draining a total watershed area of about 115 square miles. Its many wetlands effectively lessen flood damage by natural time-release of stored floodwaters.

Annual losses throughout the basin are estimated at more than $2 million. Increased urbanization and wetland development, however, coupled with existing damage potential, present a flood damage risk of over $31 million in a recurrence of the 1955 flood of record (approximately a 100-year storm). These losses can be expected to occur over a large basin area but in no concentrated damage locations.

Some flood control projects in the watershed presently protect limited areas against potential damage, but preservation of the existing natural valley storage system offers the most encompassing means for providing widespread protection. This conclusion was reached after the Stage 2 study evaluated three alternatives. Due to the dispersed nature of potential damage areas, a structural local protection system, Plan C, was not found economically feasible. Plan B, which included options such as flood proofing and other nonstructural measures can reduce the vulnerability of existing buildings to floods. Plan A was selected as the most viable, long term method to reduce flood damages throughout the Neponset watershed. It

provides for the preservation of existing wetlands and undeveloped floodplains through restrictive zoning and other existing legislation.

Massachusetts' laws and institutional mechanisms need only be applied more strictly in order to preserve existing natural floodwater storage areas. Extensive land acquistion is considered to be prohibitively costly and unnecessary.

None of the plans considered has been found to require further Federal assistance. It is recommended that the Corps of Engineers, New England Division investigations be halted with the conclusion of this Stage 2 study. It is further recommended that Plans A and B be pursued by local interests. Available engineering investigations, detailed maps and findings will be be provided to the basin communities as a basis for their individual or collective courses of action.

B. Study Authority

The December 1975 Southeastern New England (SENE) area Level B study recommended that comprehensive flood management programs, making use of nonstructural solutions wherever possible, be investigated by the Corps of Engineers. The Neponset River Basin in Massachusetts was an area identified as warranting early consideration.

The SENE Study was authorized by a resolution adopted 12 September 1969 by the Committee on Public Works of the United States Senate providing for a study to determine "... the feasibility of providing water resource improvements for flood control, navigation and related purposes in Southeastern New England ... with due consideration for enhancing the economic growth and quality of the environment." The resultant Level B study of SENE Water and Related Land Resources was completed in 1975 under the direction of the New England River Basins Commission. This investigation of flooding in the Neponset River Basin is a result of a SENE recommendation.

The Corps a completed Reconnaissance Report in November 1979, which identified past and potential flood damage sites, reviewed alternative solutions and recommended continuation into Stage 2 study efforts.

C. Scope of Study

The Neponset Flood Plain Management study is a Level C feasibility study. Data from previous water resources studies were updated and utilized in this study. Additional data were gathered and correlated where no existing information was available. Findings will be made available for local, State and Federal use to analyze flooding and other related water resources needs.

D. Study Participants and Coordination

Coordination has been maintained throughout the study with representatives of Federal, State and local agencies as well as concerned individuals. The Massachusetts Water Resources Commission is the State's coordinating agency. A number of meetings have been held to exchange information regarding flood problems and their potential solutions.

E. Other Studies

Within the Neponset watershed, a number of Federal, State, regional and local agencies have engaged in water resources investigations. A significant amount of planning data exists.

Therefore, extensive use was made of the reports listed in Table 1 to avoid duplication of study effort. Additional sources utilized in this study are included as Appendix A. The recommendations cited below in the table have not been completely carried out. The smaller studies were specific in scope.

TABLE 1
NEPONSET RIVER BASIN
MAJOR STUDIES & REPORTS

Study	Author	Date Completed	Pertinent Findings
1. Massachusetts Water Resources Study	Massachusetts Water Resources Commission	1978	Identified State planning objectives with regards to flooding and wetlands
2. Southeastern New England Water and Related Land Resources Study (SENE)	New England River Basins Commission (NERBC)	1975	Preliminary identification of flood problems and recommendation of Neponset River Basin Flood Plain Management Study
3. Small flood studies authorized under Section 205 of the 1948 Flood Control Act, as amended	Corps of Engineers	1963	Canton-construction of local protection along East Branch
		1969	Massapoag Bk-lacked economic justification
		1970	Norwood-lacked economic justification

TABLE 1 cont.

STUDY	AUTHOR	DATE COMPLETED	PERTINENT FINDINGS
		1972	Readville-inadequate local drainage
		1976	East Walpole-inadequate local drainage
		1977	Traphole Bk-lacked economic justification
4. Flood Insurance Studies (FIS)	Federal Emergency Management Agency, Federal Insurance Administration (FEMA/FIA)	--	All communities within the basin are enrolled in the National Flood Insurance Program. Studies include delineation of flood plains and stream profiles
5. Watershed Work Plans	Soil Conservation Service (SCS)	1968	Pine Tree Bk-construction of Pine Tree Brook Reservoir in Milton as a flood protection measure
		1972	Traphole Bk-recommended non-structural solutions to flooding including modifications of existing culverts and acquisition of flood plain areas.
		1975	Diamond Bk-recommended construction of a multi-purpose reservoir in Walpole, including 1180 ft. of channel work and conservation land treatment.
6. Massachusetts House Documents: 2469 & 3041	Metropolitan District Commission (MDC)	1955	Loss of Fowl Meadow Storage would increase peak flows by an estimated 20 percent.
3567	Department of Natural Resources (DNR)	1964	Recommended exploration of possible acquisition of open space land upstream of Rte. 128, more detailed study of flood preventation, and the reduction of wetland development.

TABLE 1 cont.

STUDY	AUTHOR	DATE COMPLETED	PERTINENT FINDINGS
4940	MDC and DNR	1969	Recommended a watershed management plan founded on the effects of loss of storage and acquisition of recreational lands in the interest of flood prevention.
7. Neponset River Basin Flood Plain & Wetland Encroachment Study	Massachusetts Water Resource Commission	1971	Flood stages are increased due to flood plain and wetland encroachment as much as 3.0 ft. for the 100-year event with a 50 percent loss of storage.

F. Report and Study Process

This flood plain management study was planned in three stages: Stage 1 - which culminated in the Reconnaissance Report in November 1979; Stage 2 - Development of Intermediate Plans; and Stage 3 - Development of Final Plans.

This document presents findings and recommendations of the study through Stage 2. Efforts consisted of executing the four functional planning tasks during each stage of the planning process. These tasks are problem identification, formulation of alternatives, impact assessment and evaluation.

Each iteration of these tasks incorporated a higher level of effort, detail and refinement. Re-iteration also allowed the study team to consider additional information as the study progressed. A detailed description of the standard study process follows:

Stage 1. The initial stage of the study effort evaluates the advisability of continuing with more detailed study. Efforts at this stage provide a clear indication of the scope of needs, of the area's planning objectives and constraints, and indicate scheduling and necessary management of subsequent planning activities. The reconnaissance report is the product of Stage 1 work.

Stage 2. Developing the intermediate plans requires a more detailed analysis of the problems, Stage 2 work brings forth an initial range of solutions at a general level of detail and evaluation. The final product of this stage, this report, determines the scope and direction of Stage 3 planning efforts.

Stage 3. Development of final plans, if found warranted, would concentrate on developing a select number of more detailed alternative flood protection plans. Extensive public involvement and professional evaluation would determine which plan warrants recommendation.

SECTION II

PROBLEM IDENTIFICATION

SECTION II

PROBLEM IDENTIFICATION

This section identifies the problems, needs and opportunities associated with flooding in the Neponset River Basin, the objectives in addressing these, and any planning constraints encountered.

A. National Objectives

Plans were evaluated in the interest of achieving the two coequal goals of enhancing national economic development and environmental quality. Economic development is enhanced by increasing the value of the Nation's output of goods and services and by improving national economic efficiency. The quality of the environment is enhanced by the improved management, conservation, preservation, creation or restoration of certain natural and cultural resources and ecological systems.

In additicn, Section 73 of the Water Resources Development Act of 1974 mandates:

> "(a) In the survey, planning or design by any Federal agency of any project involving flood protection, consideration shall be given to nonstructural alternatives to prevent or reduce flood damages including, but not limited to, floodproofing of structures; flood plain regulation; acquisition of flood plain lands for recreational, fish and wildlife, and other public purposes; and relocation with a view toward formulating the most economically, socially and environmentally acceptable means of reducing or preventing flood damages."

The Corps seeks plans that reduce flood damages and enhance environmental quality within the study area. Water resources planning conducted by the Corps must evaluate, through public involvement, plans solving flood problems in conjunction with other urban planning programs.

Such area objectives were compiled by meeting with state, regional and local officials. They are based upon information collected to date. This interactive planning process involved:

- Addressing specific flood problems, issues and concerns identified by the public;

- Being flexible in accommodating changing economic, social and environmental patterns and technologies;

- Integrating and complementing other urban development and management programs;

· Coordinating with affected public agencies, interest groups and individuals;

· Developing plan through an orderly, structured and open planning process;

· Ensuring plan implementation, with respect to financial and institutional capabilities and public consensus; and

· Where applicable, receiving approval by appropriate state and Federal agencies.

B. State Objectives

In 1978 the Massachusetts Water Resources Study identified certain state objectives with regard to flooding and wetlands. The Commonwealth of Massachusetts wishes to reduce flood damage to existing properties by reducing their susceptibility to flooding. It wants to improve the economy by guiding development away from flood-prone areas.

Increased flood damage must be avoided. The Commonwealth prefers non-structural measures, such as, protection of wetlands or natural flood storage from loss by development as the means toward this end. Reduction or future flood damage can be accomplished by directing development to flood-free areas.

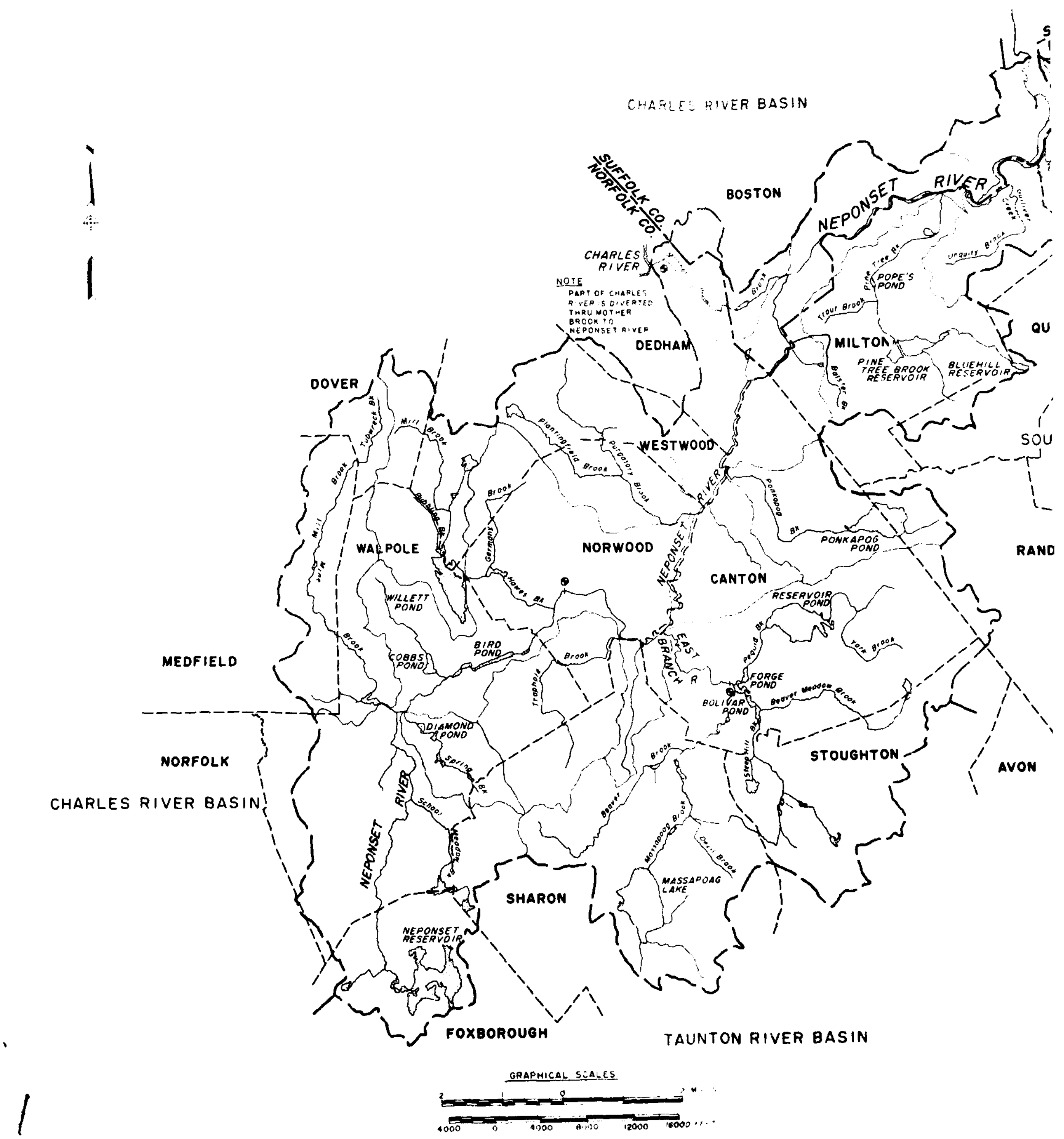
C. Existing Conditions

The Neponset River Basin is located within the Boston metropolitan area in eastern Massachusetts (see Plate 1). Following is a description of the study area. This section will discuss existing flood protection and geotechnical conditions; climatology and flooding; the environment and wetlands; the social, cultural and natural resources and land use in the watershed.

(1) Watershed.

The Neponset River drains an area of 115 square miles, consisting of rolling hills, extensive wetlands, tributary streams, lakes and ponds. It falls approximately 270 feet along its 28 mile course from its southern origin in Foxborough to its mouth at Dorchester Bay in Boston Harbor.

Along the upper and lower portions of its length, the river descends at a fairly rapid rate. The lower segment of the Neponset flows through a highly developed area consisting primarily of residences and industrial establishments. The central section between Route 1 (just downstream of the USGS Gage in Norwood) and Paul's Bridge (near the mouth of Balster Brook in Milton) is characterized by sluggish flow due to the extensive wetland area of the Fowl Meadow. The river profile along its upper reaches is steep and can act as an industrial resource for power. However, numerous


CHARLES RIVER BASIN
SUFFOLK CO.
NORFOLK CO.
BOSTON
NEPONSET RIVER
CHARLES RIVER
NOTE
PART OF CHARLES RIVER IS DIVERTED THRU MOTHER BROOK TO NEPONSET RIVER
DEDHAM
POPE'S POND
Trout Brook
Pine Tree Bk
Unquity Brook
MILTON
PINE TREE BROOK RESERVOIR
BLUEHILL RESERVOIR
QU
DOVER
Mill Brook
Tubwreck Bk
WESTWOOD
Plantingfield Brook
Purgatory Brook
SOU
Mill Brook
WALPOLE
Germany Brook
NORWOOD
NEPONSET RIVER
Ponkapog Bk
PONKAPOG POND
RAND
CANTON
WILLETT POND
Hawes Bk
RESERVOIR POND
BIRD POND
COBBS POND
EAST BRANCH R
York Brook
Pequid Bk
MEDFIELD
Traphole Brook
FORGE POND
BOLIVAR POND
Beaver Meadow Brook
DIAMOND POND
Spring Bk
STOUGHTON
AVON
NORFOLK
CHARLES RIVER BASIN
Beaver Brook
Massapoag Brook
Devil Brook
School Meadow Brook
NEPONSET RIVER
MASSAPOAG LAKE
SHARON
NEPONSET RESERVOIR
FOXBOROUGH
TAUNTON RIVER BASIN
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2
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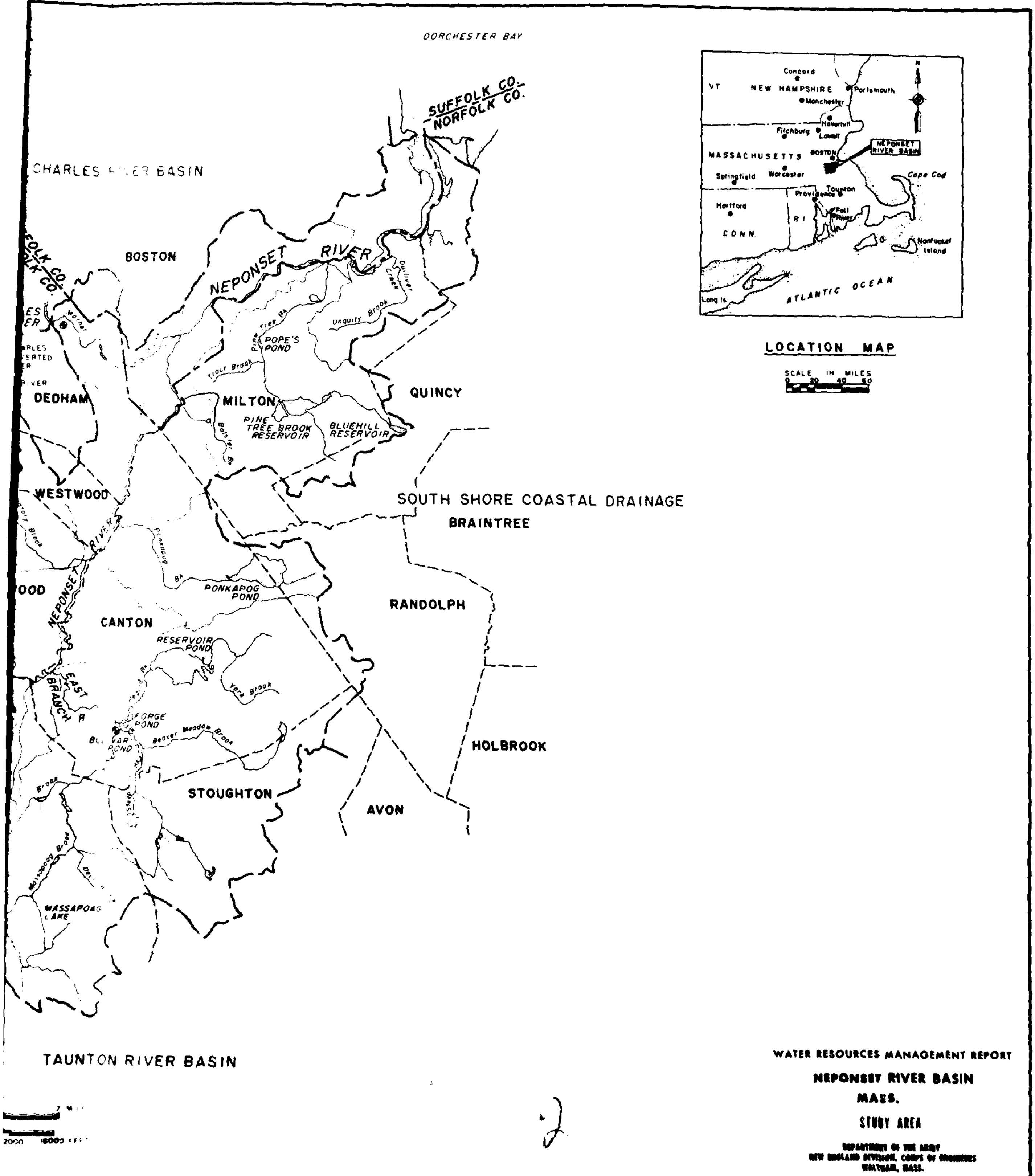


WATER RESOURCES MANAGEMENT REPORT

NEPONSET RIVER BASIN

MASS.

STUDY AREA

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

PLATE I

swamps and wetlands are located in the upland portions of the basin. The Neponset River is tidal for the lower four miles to its mouth.

Since the days of the region's earliest settlers, the river has been used as a transportation system, a harbor, a power source for industries, a water supply for municipal and industrial uses, and as a receiver of municipal and industrial wastes.

The Neponset watershed is bordered on the north and west by the Charles River Basin, on the south by the Taunton River Basin, and on the east by the South Shore coastal drainage system.

The headwaters of the Neponset originate in Foxborough at the Neponset Reservoir (W.S. 268 NGVD), a manmade impoundment of 272 acres. Immediately downstream and toward the east is Crackrock Pond. From the pond, the river flows north and is culverted under portions of the Bay State Raceway before crossing into Walpole, where it is impounded first in Smith Pond and then in Clark Pond.

From Clark Pond, the Neponset meanders northerly approximately 2.5 miles through the Cedar Swamp before flowing into Upper Blackburn Pond. The river is joined just above Upper Blackburn Pond by School Meadow Brook which drains northerly through portions of Foxborough, Sharon and Walpole. The Neponset continues northward through Walpole center and receives flows Mine and Diamond Brooks before entering Stetson Pond. Mine Brook drains southerly through the towns of Dover, Medfield, and Walpole. Diamond Brook drains northwesterly through the towns of Sharon and Walpole. The Neponset,heading northeasterly, then empties into Plimpton Pond and Bird Pond , both created by the outlet structure at Bird Pond. Just below Bird Pond is the Hollingsworth and Vose Pond located below Washington Street in Walpole.

The river continues northeasterly for about 1 mile from the outlet of the Hollingsworth and Vose impoundment into Norwood, where it is met by Hawes Brook. Hawes Brook drains portions of Dover, Westwood and Walpole via a number of small ponds and tributaries to Willett Pond. The river turns eastward at the USGS gaging station at Pleasant Street in Norwood, and then south as it passes beneath Route 1 entering the extensive Fowl Meadow.

Traphole Brook, draining portions of Sharon, Walpole and Norwood, is the first tributary to join the Neponset River during its 9-mile course through the Meadow. The river enters Canton and flows northeasterly from Route I-95 toward its confluence with Boston Harbor. A short distance dwonstream the Neponset is met by the East Branch or Canton River, a major tributary system draining 31.2 square miles including portions of Sharon, Walpole, Stoughton, Canton and Randolph. Major components of the East Branch system include Massapoag Brook, Steep Hill Brook in Stoughton, Pequid Brook in Canton, and Beaver Meadow Brook.

The Neponset River continues in a northeasterly direction, crossing Route I-95 and forming the town boundary between Canton and Norwood. Purgatory Brook, draining portions of Westwood, Dedham and Norwood, is channeled around the Norwood Memorial Airport (built on the wetland) and empties into the Neponset just upstream of the Norwood-Westwood-Canton corporate limit. Pecunit and Ponkapoag Brooks are located entirely within Canton and discharge into the Neponset just before its junction with the Westwood-Dedham-Canton town line and Route 128.

That area of the Fowl Meadow below Route 128 comprises the upstream portion of the Neponset River Reservation. The river, flowing northeasterly through the reservation to its outlet into Dorchester Bay, acts as first the Dedham-Canton and then the Boston-Milton corporate limits before entering the heavy urbanization of the Hyde Park area of Boston. Land use undergoes a radical change from this point on as the river leaves a rather tranquil marsh and enters a highly developed portion of the region's urban core. After flowing a short distance through Hyde Park, the river resumes its role as the border between Milton and Boston.

As the Neponset passes through Hyde Park, it is joined by the Mother Brook diversion. Up to one-third of the flow from the Charles River is diverted via this manmade channel from Dedham to Boston. This channel was originally constructed in 1640 to operate a water powered corn mill. Since that time it has been used as a source of power and water supply for many industries. The brook is presently controlled by the Metropolitan District Commission (MDC). Another MDC impoundment is located one mile downstream from Mother Brook at the Diamond International Company. This impoundment is used for flood control purposes and as an industrial water supply for the enterprise, formerly the Tileston and Hollingsworth Company.

Farther downstream, Pine Tree Brook, which drains portions of Quincy and Milton, meets the Neponset at Milton Village just before the Baker Chocolate Dam. The Neponset is a tidal estuary from the Baker Chocolate Dam to its confluence with Dorchester Bay in Boston Harbor. Unquity Brook, draining a small area in Milton, feeds into Gulliver Creek, one of a half dozen tidal inlets lining the estuary.

Two principal tributaries and several smaller streams contribute to Neponset River flow:

- The East Branch, also known as the Canton River, originates at Forge Pond in the center of the town of Canton. The river pursues an erratic northwesterly course for about 2.2 miles, entering the Neponset River in the vicinity of the I-95/Neponset Street interchange along the Norwood-Canton town line.

Key tributaries to the East Branch include Pequid and Massapoag Brooks, both of which flow into Forge Pond, and Beaver Meadow and Steep hill Brooks that flow into Bolivar Pond, which in turn drains into Forge Pond. The East Branch Neponset River has a total drainage area of about

31.2 square miles, characterized by small brooks and streams passing through local swampy areas.

a. Steep Hill Brook rises in the urban sector of Stoughton and flows generally westward through West Stoughton, discharging into Bolivar Pond. It falls about 180 feet in its 3.6-mile length, draining 6.1 square miles. An extensive wetland dominates the extreme lower reach of the watershed.

b. The headwater for Beaver Meadow Brook is Glen Echo Pond. This brook also flows westerly to its mouth at Bolivar Pond, falling about 105 feet along a 3.2-mile course. A large wetland potentially capable of significant storage borders the central portion of the stream.

c. Massapoag Brook originates from Massapoag Lake near the center of the town of Sharon. Heading northward, Massapoag Brook passes through a large wetland along the Sharon-Canton border before emptying into Forge Pond. The stream falls 160 feet in its 4.2-mile route and drains 7.1 square miles.

d. Pequid Brook is founded in the wetland system located in the southwestern sector of Canton. After meandering through the swamp east of Route 138, Pequid Brook dishcarges into Reservoir Pond in central Canton. From Reservoir Pond's outlet at Pleasant Street the brook continues southerly to its confluence with Forge Pond and the East Branch. Upstream of Reservoir Pond, the watershed is of typical wetland topography, resulting in a very shallow stream slope and wide flood plains. However, downstream of Reservoir Pond, Pequid Brook falls 50 feet in its last 0.8 mile. Pequid Brook drains an area of 6.3 square miles.

• Mother Brook is a continuous water canal connecting the Charles River with the Neponset River. The first canal constructed in the United States, it began operation in 1640 within 12 years of the first settlement of Boston! Legislation adopted in 1831 provides that up to one third of the Charles River flow can be diverted through Mother Brook to the Neponset.

Mother Brook flows from an inlet on the Charles, just south of the Boston-Dedham border, in a general southwest direction through East Dedham and into the Hyde Park area of Boston. Once it enters Boston, the brook changes course and continues northwesterly through Hyde Park to its confluence with the Neponset, about 1.5 miles below the Fowl Meadow. Mother Brook's natural drainage area is 1.9 square miles; however, the Charles River watershed at its inlet into Mother Brook is approximately 198.6 square miles. The brook falls 50 feet in its 2.5-mile length.

• Other Tributaries to the Neponset River include: School Meadow, Mine, Diamond, Hawes, Traphole, Purgatory, Pecunit, Ponkapog, Pine Tree, and Unquity Brooks.

a. School Meadow Brook rises in the wetlands in the vicinity of the Walpole-Foxboro-Sharon town line junction north of Dudley Hill. In its upper reach, the stream follows a steep grade northward through Walpole to Route 1, falling 70 feet in 1.5 miles. It then heads northeasterly through a large wetland, dropping only 10 more feet in elevation in its final 1.5 miles before meeting the Neponset River above Upper Blackburn Pond. School Meadow Brook drains an area of 3.2 square miles.

b. Mine Brook originates from the outlet at Jewells Pond in eastern-central Medfield. Heading in a general southeastern direction from Jewells Pond, Mine Brook drops approximately 20 feet in its first mile. The brook then flattens out as it flows into Walpole through an extensive wetland of over 200 acres, falling only 30 more feet in its last 3 miles. Mine Brook discharges into Turner Pond and meanders southeastward, emptying into the Neponset River near Walpole center.

c. Diamond Brook has a drainage area of about 2 square miles and begins at Moose Hill in the town of Sharon. The stream flows northwesterly through a series of ponds and the business area of Walpole to its confluence with the Neponset River. The watershed is about 2.5 miles long. Elevations in the watershed range from 130 feet above mean sea level at its outlet to 520 feet on Moose Hill.

d. Hawes Brook is located in the town of Norwood and drains an area of approximately 8.7 miles. It originates in Willett Pond, located on the Walpole-Norwood town line. Willett Pond is fed by Mill and Bubbling Brooks, draining large portions of Westwood and Walpole along their contínguous border.

From Willett Pond, Hawes Brook heads southeasterly to its confluence with the Neponset River meeting Germany Brook at Ellis Pond, just downstream of the outlet of Willett Pond. Germany Brook flows westerly from the wetland along the Westwood-Norwood corporate limit, then southerly to Ellis Pond. Hawes Brook then continues southeasterly through Norwood where it empties into the main stem upstream of the USGS gaging station on the Neponset. The stream falls 80 feet in 2 miles from Willett Pond to its mouth.

Mill Brook has its cource in the highlands of southeastern Dover, near Strawberry and Oak Hills. Flowing south-southeasterly through Westwood it is joined by Bubbling Brook just upstream of the inlet to Willett Pond. There is another stream in Medfield, tributary to Mine Brook, also named Mill Brook.

e. Traphole Brook has a drainage area of about 3.5 square miles and begins at Moose Hill in the town of Sharon. This stream flows gnerally north to Union Street in East Walpole, then easterly to the Neponset River. The brook is about 4.5 miles in length and has a fall of about 250 feet. Traphole Brook has a very steep slope for most of its length before entering the Fowl Meadow and meandering for almost a mile toward its outfall into the Neponset River just above I-95.

f. Purgatory Brook has its origin in the large wetland east of the Islington section abutting Dedham in Westwood. The stream flows southeasterly into Norwood, under Route 1, and enters the Fowl Meadow. It as a steep slope through this upper reach, dropping 120 feet in about 2.5 miles.

Upon joining Plantingfield Brook, Purgatory Brook meanders for 1 mile toward Norwood Memorial Airport. It is then channeled eastward around the airport ot its junction with the Neponset River, just upstream of the Westwood Industrial Pakr. Purgatory Brook drains an area of 6.4 square miles. Flow through the Fowl Meadow is sluggish due to the characteristic wetland topography.

Plantingfield Brook's source is found in the highlands near Fox Hill in Westwood. This water course also flows southeasterly into Norwood. Once it passes under Washington Street in Norwood, the brook continues eastward under Route 1, enters the Fowl Meadow, and meets Purgatory Brook above Norwood Memorial Airport. Plantingfield Brook falls approximately 190 feet along its 2-mile length.

g. Pecunit Brook is located entirely within Canton. Its headwaters are found in a wetland just north of the Randloph-Washington Streets intersection. The brook flows northwesterly, under I-95, and meets the Neponset River near the upper end of the Westwood Industrial Park. Pecunit Brook drops 40 feet along its 2.5-mile course.

h. Ponkapog Brook originates at Ponkapog Pond on the Canton-Randolph town line. The brook follows a westerly course for 1.2 miles, where it changes direction and heads northwesterly for its final 2 miles through a large wetland to its mouth. Located entirely within Canton, Ponkapog Brook discharges into the Neponset River near the I-95/Route 128 interchange adjacent to the Fowl Meadow.

At first, the stream profile is steep, falling 90 feet in its first 1.2 miles. It then flattens out through the wetlands, dropping only 10 feet in elevation for the rest of its 2-mile length. Ponkapog Brook drains an area of 4.5 square miles.

i. Pine Tree Brook begins at the outlet to the Blue Hills Reservoir located in the Blue Hills Reservation in Quincy. It falls rapidly, almost 200 feet in 1.3 miles, as it heads northwesterly to Route 28 (Randolph Avenue) in Milton. The stream then turns southwesterly and empties into Pine Tree Brook Reservoir, which drains the northern slopes of the Blue Hills Range.

From Pine Tree Brook Reservoir, the brook flows northerly under Canton Avenue and into Popes Pond. There it changes direction and continues northeasterly under the Blue Hills Parkway through Milton Center to Turners Pond, where it then flows northerly toward its outfall into the Neponset River at Milton Village, just above the Walter Baker Dam.

Pine Tree Brook has a shallow slope from Pine Tree Brook Reservoir to its mouth, falling approximately 30 feet in 3.5 miles. The stream's drainage area of 8.7 square miles is contained almost entirely within Milton.

j. Unquity Brook has its source above Randolph Avenue near Milton Center. It flows northeasterly to Adams Street where it discharges into Gulliver Creek. The tidal extension is adjacent to the Southeast Expressway.

(2) Flood Protection.

There are a number of flood protection measures within the Neponset River Basin that effectively have kept flood damages to a minimum.

* Diamond Brook - The Soil Conservation Service (SCS) has reported that construction of a multipurpose flood prevention and fish and wildlife structure is nearly complete. Located just upstream of Wahsington Street, the plan includes a 17-acre pool, 780 feet of reinforced conduit supplementing an existing conduit through Walpole center, and 400 feet of stream channel enlargements. Together with conservation land treatment, protection will be provided for a storm equal to that of 1955, or an estimated 99 percent reduction in annual flood losses along Diamond Brook. The project is authorized under the Watershed Protection and Flood Prevention Act (Public Law 83-566; 68 Stat. 666), as amended.

* Sharon - In response to the August 1955 floods, the Department of Public Works initiated a maintenance program for hydraulic structures within the town. In addition, during a major storm water levels on the numerous ponds and lakes in the town are monitored and regulated.

* Norwood - As a result of the August 1955 flood and the March 1968 storm, both major and minor flood protection measures were taken in Norwood.

a. One major undertaking was the relocation and dredging of the Neponset River during the construction of I-95 in the vicinity of Neponset Street. The Neponset Street culvert was enlarged at this time, with the result that the street, which was impassable during the 1955 hurricane flood was not flooded in the 1968 storm. The river was widened from Traphole Brook to Morse Street.

b. Dikes were built with private funds around the Factory Mutual buildings and the original building of the Shield Chemical Company. The newer Shield Chemical building was built 8 feet higher.

c. Culverts and bridges were rebuilt on Plantingfield Brook (Route 1), Meadow Brook (U.S. Route 1 and Dean Street), Hawes Brook (Washington Street), Traphole Brook (U.S. Route 1) and Purgatory Brook (U.S. Route 1, Everett Street and the railroad right-of-way at State Route 1-A). Channel

relocation occurred on Plantingfield Brook (from a point east of U.S. Route 1 to Purgatory Brook), Meadow Brook (placed in a culvert from a point east of Dean Street to the Neponset River), Hawes Brook (from a point approximately 200 feet west of Washington Street to the Neponset River) and Purgatory Brook (from Norwood Memorial Airport to Route 1, at the culvert at Everett Street near David Terrace). A protective berm was built at the end of the David Terrace area in conjunction with the relocation.

The Pleasant Street Bridge over the Neponset was replaced in 1970. The old structure had been undermined in the storm of 1968. Revetments were placed along the banks between the railroad and Pleasant Street Bridges along the Neponset in 1974.

• Canton Local Protection - The Canton flood protection works are located along the East Branch Neponset River jsut west of the center of Canton, about 2 miles upstream of the confluence of the two main stems. It was built by the U.S. Army Corps of Engineers under authority granted by Section 205 of the Flood Control Act of 1948 as amended. The project would avert $5.1 million in flood damages in a recurrence of the 1955 flood of record.

The project consists of a concrete overflow dam 160 feet long located adjacent to the Plymouth Rubber Company dam, a diversion channel below the dam about 1,600 feet long with rock-faced walls, and a small intake structure diverting processing water to the rubber company plant. Construction was started in 1962 and completed in July 1963. Local interests operate and maintain the project.

The improvement provides flood protection for the town's largest industry, a rubber processing firm, along both banks of the river downstream of Forge Pond, and for several commercial firms along the town's main street.

• Metropolitan District Commission - Control of the Neponset River from the Walter Baker Dam to Traphole Brook in Sharon, and control of Mother Brook rests with the Metropolitan District Commission (MDC). The authority to regulate and maintain the two watercourses was granted to the MDC by the Commonwealth of Massachusetts after the 1955 flood.

The MDC has been engaged in a long term process of making improvements to the water courses within its jurisdication. The Neponset River was divided into three sections or reaches, and efforts have been made to make improvements on a reach-by-reach basis. Reach I is defined as the lowest reach within the MDC's jurisdiction, between the Walter Baker Dam at Adams Street to the dam at Diamond International Company's Hyde Park Paper Division's plant (formerly the Tileston and Hollingsworth Company) on River Street. Reach II is defined as the reach between Diamond International's dam and Paul's Bridge on Milton Street. Reach III is defined as the uppermost reach from Paul's bridge through the Fowl Meadow to Traphole Brook at the Norwood-Sharon town line.

All work within Reach I has been completed. This consisted of:

- lowering the spillway crest of the Walter Baker Dam
- removal of the Jenkins Dam
- protection of the Massachusetts Bay Transit Authority's bridge downstream of Blue Hill Avenue
- channel improvements downstream of Blue Hill Avenue
- channel improvements and dam removal upstream of Blue Hill Avenue

All work within Reach II was completed by 1968. This consisted of:

- installation of a new dam at the Diamond International Plant
- installation of new footbridges at Glenwood Avenue and B Street
- repair to the railroad bridge upstream of Glenwood Avenue
- channel relocation from upstream of Glenwood Avenue to Paul's Bridge
- dredging of the Neponset channel at various locations.

Work with Reach III had been planned from Milton Street in Boston (Paul's Bridge) to Traphole Brook in conjunction with the completion of I-95 north of State Route 128, but this will not be accomplished due to termination of funding.

The MDC operatres the dam at the Diamond International location in Hyde Park. This dam was constructed to include movable bascule gates which allow the crest elevation to vary. During times of peak flood discharge the crest is lowered, allowing more flow to passthe dam for a given stage and thus controlling the water level.

- Mother Brook - The MDC has also accomplished flood protection work along Mother Brook. A new diversion dam at the Charles River was completed in 1958, and channel improvements between the dam and Maverick Street were completed in 1959. A new dam at Knight Street in Boston, a new bridge at River Street in Boston, channel improvements in the vicinity of the Boston-Dedham line, a new sluice gate at the United Waste Company dam and new flashboards at the Colburn Street dam in Dedham were all completed in 1977-78.

- Dedham - The town of Dedham also has undertaken measures to increase floodflow capacity on smaller brooks. The brook in the Readville Manor area from Sprague Street eastward across Kensington Street has been dredged. The Old Bussey Street Bridge on Mother Brook has been replaced with a larger structure. In addition, the small dam a few hundred feet downstream of Bussey Street was breached, and stop logs were added to allow some water level control upstream of the dam.

- Pine Tree Brook - The town of Milton completed an extensive program of channel improvements on Pine Tree Brook in the mid-to-late-fifties. Those improvements lessened, to a degree, the flooding potential throughout

the watershed. In 1970, SCS completed the Pine Tree Brook Watershed improvement project under authority granted by Public Law 83-566. An earth dam, with an ungated outlet works, was constructed near the headwaters creating Pine Tree Brook Reservoir.

This multi-purpose structure has a storage capacity of 1,120 acre-feet impounding an area of about 95 acres, representing 4.9 inches of storage on the 4.3 square miles of controlled drainage area. While providing a habitat for native wildlife, the project controls flood flows. Normal flows are allowed to pass under the spillway, but flood flows are stored and released over a longer time period. This facility provides almost complete protection against major floodwater damage caused by a 100-year event.

(3) Geotechnical Conditions.

The relief of the Neponset watershed is low to moderate with generally a rolling surface. This varied relief is caused by irregularly eroded bedrock covered by glacial deposits. Exposures of rock are scattered throughout.

The study area has been glaciated, resulting in the deposition of unconsolidated surficial materials. Recent deposits are swamp and marsh materials and artificial fills.

Bedrock consists of igneous, sedimentary, and metamorphic types. Through geologic time the rocks have been structurally deformed. A number of faults traverse the basin.

An inventory of geologic and topographic features is included as Appendix "B."

(4) Climatology and Flooding.

The climate of the Neponset watershed is typical of lower coastal New England--variable and characterized by periods of heavy precipitation.

The average annual temperature is about 47°F. The mean January temperature is about 25°F, and the mean July temperature is approximately 69°F. In the summer months, the high temperature has reached approximately 101°F; while during the winter months, the temperature has dropped to below -20°F on rare occassions. Average daily and extreme monthly temperatures for the Neponset River Basin are summarized in Appendix C.

Average annual precipitation totals nearly 47 inches. Of this,about 21 inches are discharged from the area as streamflow. The average snowfall in Boston is about 43 inches and may occur in appreciable amounts from November through April each year. Snowfall depths vary widely from

year to year, depending greatly on the track taken by winter storms. The water content of the snow cover in the late winter or early spring seldom averages more than three inches. Precipitation data for the Neponset watershed is summarized in Appendix C.

The length of the growing season, the frost free period above 32°F, averages about 170 days. Growing seasons vary from less than 150 days inland to nearly 200 days along the immediate coastal areas, usually from the beginning of May to mid-October.

New England is influenced by constant conflicts between cold dry air masses flowing out of the great subpolar region to the northwest and the warmer moisture-bearing tropical air from the south. The tendency of most of the general cyclonic disturbances to skirt the polar front brings their paths of movement through the region and results in a somewhat regular succession of storms. The most active precipitation-producing storms are those in which the moist southwest or east winds flow over the uplands and are forced aloft over cold resident air to condensation levels. In addition, severe coastal disturbances occur when deep low-pressure areas pass over or near the area. A storm of tropical origin may reach the area at nearly full intensity since it has passed mostly over water prior to coming inland. These storms, locally known as "nor'easters," are heavily laden with moisture from the ocean.

Winter coastal storms often bring rainfall to the Neponset watershed, in contrast to snow in interior portions of the State. Orographic influences on the climate are minor, owing to the relatively small extremes of elevation within the area. Hurricanes can occur, particularly during August, September and October.

Significant flooding has occurred in the Neponset River Basin as a result of the storms of February 1886, March 1936, July 1938, August 1955 and March 1968. The flood of 1886 is reported to have been the greatest in the area, exceeding the 1938 flood stage near Mother Brook by an estimated 3 feet. The flood or record, however, is that caused by Hurricane Diane in 1955.

• August 1955 - Hurricane Diane is the flood of record for the watershed. Extensive flooding resulted mostly in basement damage, with water inundating first floor levels in some areas. Sewers overflowed and created potential health hazards. Septic systems were over saturated , and wells filled with contaminated water.

Two hurricanes, Hurricane Connie and Hurricane Diane, passed over the Neponset River Basin in mid-August 1955. Although Hurricane Connie did not result in substantial rainfall, it did leave the ground saturated. This storm lasted from 11-13 August and deposited 2.02 inches of rain at the National Weather Service's Blue Hills station in Milton. On 17 August an additional 0.53 inches of precipitation was recorded. That day Hurricane Diane passed inland over North Carolina and Virginia and then turned

eastward along the coast. Between 18 and 19 August, Hurricane Diane dropped 11.94 inches of rain at the Blue Hills station. On 19 August alone over 7 inches were recorded. Heavy rain fell for more than 30 hours. According to the National Weather Service in Boston, this was the highest recorded since its establishment. The effects of Hurricane Diane on the watershed as recorded by gaging stations are presented below.

TABLE 2
Neponset River Basin
Hurricane Diane, 1955

Gaging Station Number	Gaging Station Location	Maximum Elevation (NGVD)	Peak Discharge (CFS)	Date
I-1050	Norwood, on left bank, near Pleasant Street. (35.2 sq. mile Drainage Area)	58.69	1,490	19 August
I-1055	Canton, on right bank of East Branch near Washington Street. (27.2 sq. mile Drainage Area)	88.36	1,790	19 August
I-1104	Dedham, Mother Brook near Charles R. (66.0 sq. mile Drainage Area)	92.87	970	24 August

Major damage centers included Walpole Center, virtually isolated by floodwaters several feet in depth; the industrial concerns of Bird and Son, Inc., Fales Machine Co., Kendall Co., Hollingsworth and Vose, Sun Chemical Co., Allis-Chalmers, Tileston and Hollingsworth (now Diamond International), the Plymouth Rubber Co., American Tool Co., the E.L. Dampney Co.; Factory Mutual Co; the residential sections of Islington in Westwood and Ellis Garden in Norwood, along with Canton Center; the Readville Manor area of Dedham; and the Pine Tree Brook watershed in Milton. Many roads and bridges were impassible; hundreds of people had to evacuate their homes; and temporary work shutdowns resulted in thousands of dollars in lost wages.

Although a comprehensive damage survey has never been made, research into past records and documentation indicates monetary damage suffered in the Neponset River Basin to be in the neighborhood of $6 million (1955 price levels). Industrial and commercial establishments accounted for about 75 percent of the damages sustained, residential structures under 10 percent and municipal and other the remaining 15 percent. It is interesting to note that $6 million in 1955 would be equivalent to an amount in excess of $31 million today! Hurricane Diane was estimated to

have had a frequency in excess of 100 years.

· March 1968 - Although the March 1968 storm was less severe than Hurricane Diane in 1955, damage was extensive. Following the 1955 storm, many local towns, private businesses, and State and Federal agencies took steps to minimize future harm. Flood control works constructed after 1955, for example, averted much damage. Despite these efforts, continued flood plain development in the interim period is prone to substantial flood damage.

Snow cover was above normal and water content was high in March 1968. As the snow melted, it saturated swamps and lowlands, and increased streamflows. Intense rainfall on 12-13 March melted much of the remaining snow cover and raised the groundwater table. Antecedent moisture conditions were a factor in causing the abnormally high flood elevations that resulted from heavy rainfall on 17-18 March. A total of 7.74 inches of precipitation was recorded at the Blue Hills Station in Milton: 1.97 inches the first day, 5.61 inches the following day, and 0.16 inches the last day. Recorded data from gaging stations within the watershed are presented below.

TABLE 3
Neponset River Basin
March, 1968

Gaging Station Number	Gaging Station Location	Maximum Elevation (NGVD)	Peak Discharge (CFS)	Date
I-1050	Norwood, on left bank of Neponset near Pleasant St. (35.2 sq. mile Drainage Area)	54.52	1,140	18 March
I-1055	Canton, on right bank of East Branch, near Washington St. (27.2 sq. mile Drainage Area)	87.05	1,420	18 March
I-1104	Dedham, Mother Brook near Charles R. (66.0 sq. mile Drainage Area)	87.15	1,040	21 March
—	Hyde Park, MDC dam at Diamond International Co. on Neponset R. (formerly the Tileston and Hollingsworth Co., 163.8 sq. mile Drainage Area including Charles R.)	38.6	1,550	20 March

Locations of significant flooding included Kendall Co., Fales Machine Co., Sun Chemical Co., New London Mills and the University Avenue industrial area in Westwood; the Islington section and center of Norwood; Norwood Memorial Airport; Canton Center; the residential area adjacent to Mother Brook; and the Readville Manor section of Dedham.

The U.S. Geological Survey reported that the 1968 flood had a recurrence interval of 40 years at the Norwood gaging station on the Neponset River. That is a 2 and 1/2 percent chance of occurring in any given year. Flood damages were reported to be about $1.5 million (1968 price levels) for the Neponset River Basin. This is equivalent to almost $5 million in today's dollars!

· Other - A flood in February 1886 is reported to have been the greatest in the Neponset River Basin, since at least 1800, and probably since the early 1700's. Flooding of the Fowl Meadow marshes along the Neponset River has also occurred in 1807, 1898, 1936, July and September 1938, 1944, 1948 and 1954. However, available information regarding these past events is sketchy at best.

Following the floods of 1938, the Commonwealth of Massachusetts authorized a survey of damages. This survey disclosed losses of $53,000 in the Neponset watershed (1938 price levels). No damage or loss information was available for the other flooding events.

(5) Environment.

The Neponset River Basin contains a variety of fish and wildlife habitats supporting a diverse population of fish and wildlife species. Forest, agricultural and open land, wetlands, and open water are the most significant habitats. These areas cover about 60 percent of the watershed area. Thus, the basin's proximity to metropolitan Boston and its urban character has little influence on its environmental potential. There is still a signifcant amount of habitat remaining to support fish and wildlife resources. An inventory of fish and wildlife resources is included as Appendix "D."

In addition, the Neponset Conservation Association (NCA) has sponsored selected portions of the Neponset watershed for designation by the Commonwealth of Massachusetts' Secretary of Environmental Affairs as Areas of Critcial Environmental Concern (ACEC). The effect of designation under the Massachusetts Environmental Policy Act (MEPA) is two-fold: The first is a lowering of "thresholds" for review - projects normally excluded from MEPA review are not excluded in an ACEC. All projects of whatever magnitude that require state funding, permit(s), approval or other authorization are reviewed by the MEPA staff through the filing of an Environmental Notification Form. Such review applies to planning and policy development as well as actual construction projects. Although a full Environmental Impact Report is not necessarily required, projects within an ACEC would be subject to a higher standard of review thereby

contributing to the protection of the area's environmental values.

The second effect of the designation is a directive to agencies of the Executive Office of Environmental Affairs, e.g. the Metropolitan District Commission, the Department of Environmental Management, the Department of Environmental Quality Engineering and the Massachusetts Water Resources Commission, so that they take action to administer programs and/or revise regulations in order to protect the area and ensure that activities in or impacting the area are designed and carried out to minimize adverse environmental effects.

ACEC designation does not itself prohibit or restrict development, nor does it remove or interfere with local control or current zoning. And although there are some state permits which do not trigger the review process, most projects of significant magnitude, including private development, are presently subject to MEPA review through state licensing. Thus, the net effect of the ACEC status is greater scrutiny of state and other projects in order to provide a greater degree of environmental protection.

The report prepared by NCA and submitted for ACEC consideration is included as Appendix "E."

(6) Wetlands.

• Overview - Inland wetlands are defined under Chapter 131, Section 40 of the Massachusetts General Laws as any wet meadows, marshes, swamps, bogs, areas where ground water, flowing or standing surface water or ice provide a significant part of the supporting substrate for a plant community for at least five months of the year, emergent and submergent plant communities in inland waters; and that portion of any bank which touches any inland waters. These wetlands are valuable for a multitude of water resource purposes and can be used most significantly for floodflow reduction. They are also important for fish and wildlife habitats, water quality preservation, groundwater aquifer protection, recreation and visual quality.

The wetlands in the Neponset River Basin provide natural storage areas which act to reduce floodflows. Elimination of these wetlands by development would only serve to increase the amount of runoff, with an accompanied increase in floodflows and flood damage. The loss of these natural valley storage areas would no doubt cause flooding of property that was not previously flood prone.

Flood damage reduction is not the only economic benefit. There are many other benefits that can be derived from protecting wetlands from unnecessary development. They are also valuable for such uses as open space, buffer strips, wildlife habitat, and maintenance of streamflow during periods of low runoff. Wetlands gradually release water which has been stored during storms, as well as groundwater, thus maintaining a

steady flow in streams. In the Charles River Basin it has been found that flood peaks in the upper portions of the basin are so retarded by natural valley storage that they do not reach the lower Charles until three to four days after the flood peak generated downstream has passed.

Wetlands are generally poor sites for development because of high water tables and the flooding hazard. However, there is a growing concern that as good building land becomes scarce, the economic feasibility of using wetlands as building sites will steadily increase. It is expected that many wetlands in the watershed will come under increasing pressure for development. If these wetlands are developed indiscriminately with no controls, serious flood damage problems can be expected in the future. Existing legislation, discussed later, requiring review and permits have contributed to keeping flood losses to a minimum. Table 4 lists wetland area (in acres) by community within the Neponset River Basin.

TABLE 4
NEPONSET RIVER BASIN
WETLAND AREA

Community	Wetland Areas (acres)
Boston	60
Canton	2,965
Dedham	320
Dover	130
Foxborough	80
Medfield	350
Milton	355
Norwood	1,120
Quincy	75
Randolph	85
Sharon	1,320
Stoughton	360
Walpole	1,565
Westwood	455
TOTAL	9,240

As can be seen from above, the Neponset watershed contains a significant amount of wetlands - accounting for nearly 13 percent of the watershed. The largest of these extends from Milton and Boston along both banks of the Neponset River through Dedham, Westwood, Norwood, Canton and Sharon. This wetland area is designated as the Fowl Meadow. Extending for nearly 3,100 acres, this wetland represents over one-quarter of the total amount of wetland area within the watershed. Since a major portion is located in the flood plain along the banks of the river, it provides additional channel capacity during flood periods to help pass floodflows, as well as providing a large volume of storage for detention of potential floodwaters.

The second largest wetland area is Cedar Swamp. Located in the town of Walpole, it covers approximately 1,030 acres. These two wetlands make up almost 37 percent of the total wetland area within the Neponset River Basin. The remainder is distributed fairly well throughout the upper sections of the watershed.

An analysis of the impact of these wetlands on flood stages was completed last year. This investigation updated and confirmed conclusions made in 1971 by a consultant to the Massachusetts Water Resource Commission. The 1971 study found that basinwide flood stage increases for the 100-year flood range from 0.5 feet with a 10 percent loss of wetland storage, to 3.0 feet with a 50 percent loss of storage.

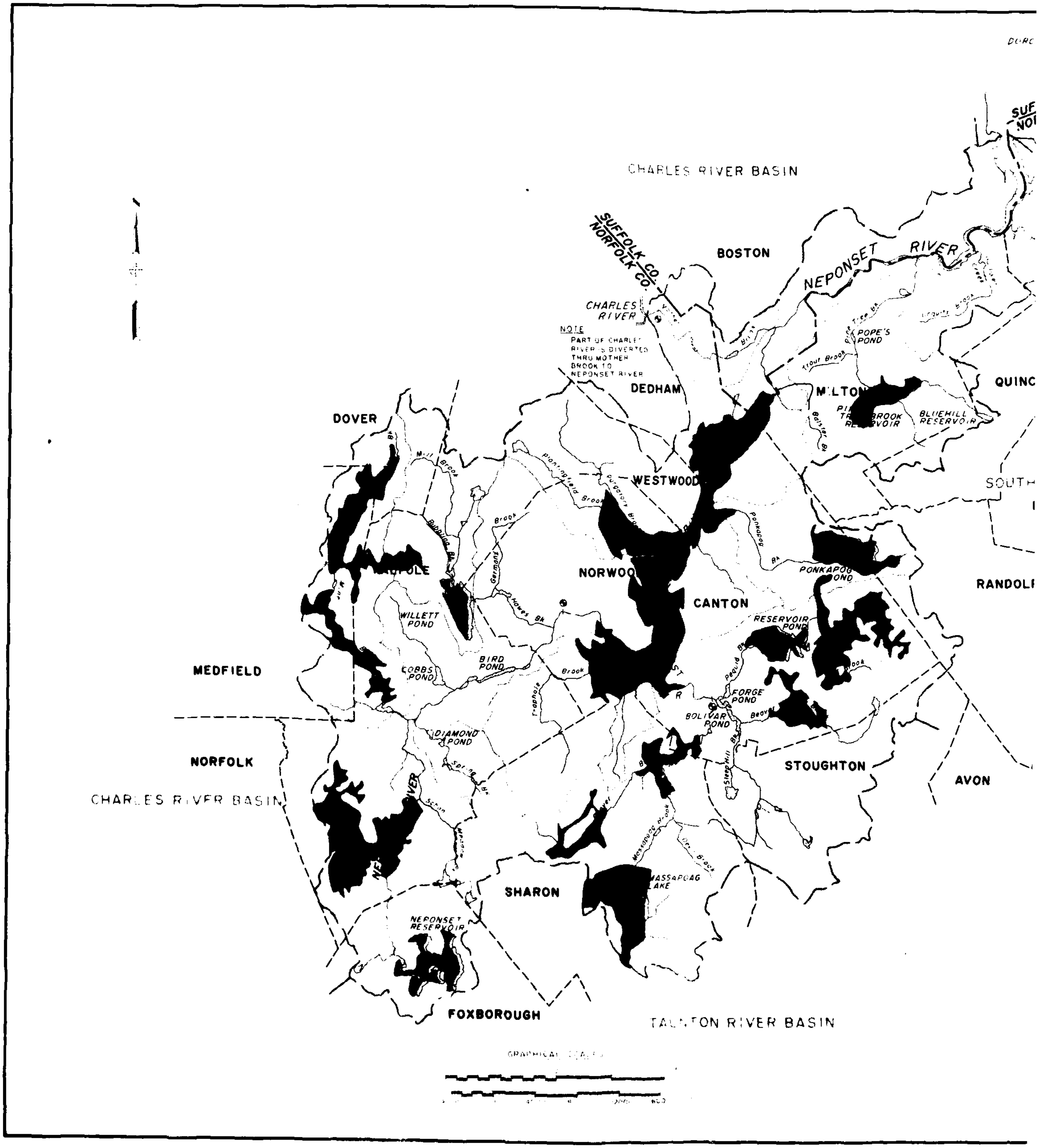
The more recent analysis, using a better and more accurate data base, indicated that flood stages could increase as much as 6.5 feet and 10.0 feet for the 100-year and standard project flood events respectively without modification by existing storage. This hydrologic and hydraulic exercise is documented as Appendix "C."

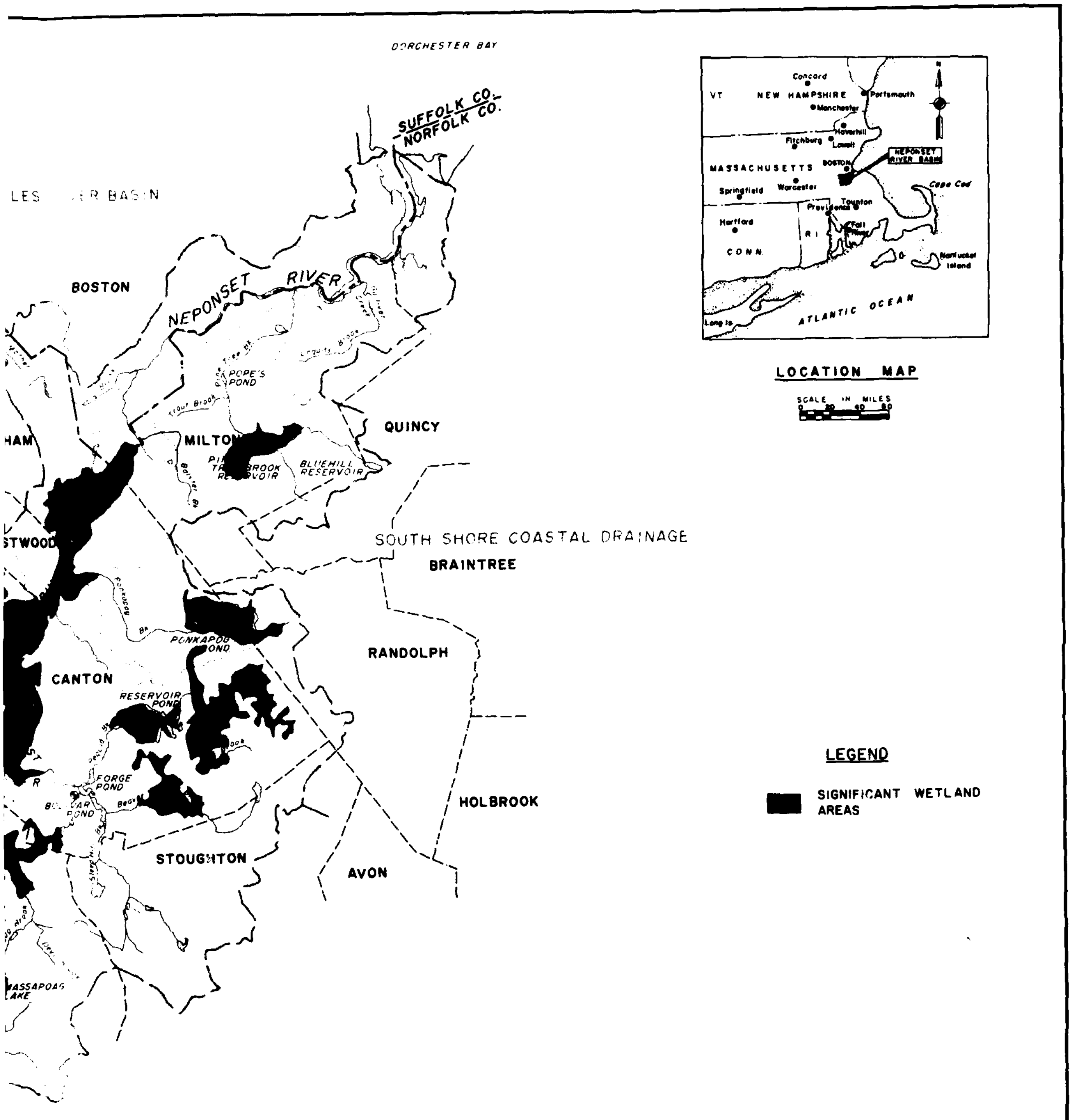
Table 5 lists significant wetland areas and their location within the Neponset watershed. They are shown on Plate 2.

Table 5
NEPONSET RIVER BASIN
SIGNIFICANT WETLANDS

Name	Location	Area in Acres
Fowl Meadow	Neponset Main Stem	3,100
Cedar Swamp	Walpole	1,030
York & Pequid Brooks	Canton-Stoughton	690
Massapoag Lake	Sharon	370
Purgatory Brook	Norwood	370
Mine Brook	Walpole-Medfield	230
Neponset Reservoir	Foxboro	225
Beaver Meadow Brook	Canton	210
Ponkapog Pond	Walpole-Westwood-Sharon	200
Reservoir Pond	Canton	160
Beaver Brook	Sharon	150
Pine Tree Brook Reservoir	Milton	95
TOTAL		6,830

In 1955, the Massachusetts Legislature authorized a study to review the feasibility and advisability of draining the marshes and "reclaiming" them for such uses as "wildlife reservation or other public or private purposes" (Chapter 56, Resolves of 1955). The report found: "On the


CHARLES RIVER BASIN
SUFFOLK CO.
NORFOLK CO.
BOSTON
NEPONSET RIVER
CHARLES RIVER
NOTE
PART OF CHARLES RIVER IS DIVERTED THRU MOTHER BROOK TO NEPONSET RIVER
DEDHAM
MILTON
POPE'S POND
QUINC
BLUEHILL RESERVOIR
DOVER
WESTWOOD
SOUTH
NORWOO
CANTON
PONKAPOG POND
RANDOLF
WILLETT POND
BIRD POND
COBBS POND
RESERVOIR POND
MEDFIELD
FORGE POND
BOLIVAR POND
DIAMOND POND
NORFOLK
STOUGHTON
AVON
CHARLES RIVER BASIN
SHARON
MASSAPOAG LAKE
NEPONSET RESERVOIR
FOXBOROUGH
TAUNTON RIVER BASIN
GRAPHICAL SCALES



WATER RESOURCES MANAGEMENT REPORT

NEPONSET RIVER BASIN
MASS.

WETLANDS

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

PLATE 2

assumption that the land along the Neponset is to be used for development purposes, the present channels of the River ... are not adequate. Being designed to take only summer floods, even the average annual spring floods put some water over the marshes." Furthermore, in estimating the volumes of floodwater, the accuracy of the figures was qualified because" ... they neglect the very great effect which the storage of water in the meadows has on floods at the lower end." The effect of the marshes on flow equalization was also noted: the confining of the flows of the Neponset River at flood times in a channel, as is proposed here, would mean increasing to some extent the peaks of the floods in the river below the dam of the Mattapan Mills, because it would eliminate the large amount of water stored in the Fowl Meadow .... This storage area acts in much the same manner to reduce flood peaks (and to equalize flow) as some of the artificially constructed flood control reservoirs now being built on some rivers." (H 3014 June 1955).

(7) Social Environment.

• History - "The village (in Milton) called the 'Mills' comprising a part of Dorchester, at the head of navigation of the Neponset, is a wild, romantic place, and ever since the first settlement of the country, has been the seat of considerable trade and manufacture ... (In Canton) the east branch of Neponset River and several large ponds and reservoirs give this town extensive water power. There are in the southern village, two rolling mills, for the manufacture of copper bolts and sheathing, on a large scale; two furnaces for refining copper, and casting bells and brass cannon (operated by Paul Revere): forges and furnaces for the manufacture of iron wheels and axles for railroad cars ... The viaduct or railroad bridge, over one of the ponds and river at this place is conceded to be the most elegant and massive structure of masonry in the United States. It cost the company ninety-three thousand dollars. It is six hundred and fifteen feet in length, connected at intervals by buttresses five and a half feet thick ... Near the bottom are six large arches, for the passage of water, and in another place is an arch still larger, through which passes a town road ... The Fowl Meadows, so called, a large portion of which are in Canton, extend seven miles in length with varying breadth. The meadows contain excellent peat; and will in process of time ... furnish a supply of fuel almost inexhaustible." (Gazetteer of Massachusetts, John Hayward, Boston, 1947 pp. 203, 121.)

Between 1893 and 1903, the Fowl Meadow was acquired by the Metropolitan District Commission for its Neponset River Reservation. Included are lands in Boston, Canton, Dedham, Milton and Westwood. The river reservation remained relatively unchanged until the last decade, when the widening of Route 128 divided the Fowl Meadow into two parts. Interstate 95 now intersects Route 128 east of the Neponset River in Canton.

The industrial history of the Neponset is still reflected in the character of the development along its upper sections in Walpole, Canton and Norwood and along its lower reaches adjacent to its banks in Boston,

Milton and Quincy. Today, industrial development is prospering near the intersection of Routes 128 and I-95, but industrial dependence on the river is fading. New industries do not need water power.

• Population and Economy — The economic history of the Neponset watershed shows graphically how changing technologies can change growth patterns. The early economic development of the basin was constrained by the need for industry to locate along the river to use the water for power and processing. The outlying towns began as farming communities.

When water power was no longer a factor, the concentration of industry at the river's edge was reduced. Businesses not using process water located near good transportation facilities for better access to markets.

The post World War II expansion of the highway system -- Routes 128, 95 and 3 -- led to industrial and residential growth throughout the basin. Farmland became scarce, and most large undeveloped areas were publicly owned. The basin began to assume an urban-suburban character.

The basin's economy is quite diversified. Of all workers in the basin, wholesale and retail trade employs 30 percent; manufacturing 22 percent; service industries 17 percent; finance and real estate 16 percent; transportation, commerce and utilities 9 percent; construction 6 percent and agriculture and mining less than 1 percent.

The relative diversity of industrial output has helped to make the basin's economy fairly stable. In the manufacturing sector, the dominance of nondurable goods production has in the past contributed to stability. Industries that produce nondurable goods are not as sensitive to cyclical fluctuations in the general economy.

In the future, however, nondurable goods production is expected to assume a declining share of the region's economy. Therefore, the moderating effect of the nondurable industry will lessen, forcing the basin's economy as a whole to become somewhat less stable.

From 1965 to 1975 the population in the watershed increased 6 percent. The basin population in 1980 was approximately a quarter of a million - nearly the same as it was in 1975. This resulted in a population growth over the latter 15-year period (1965-1980) of only 4 percent!

Future development is likely to be concentrated in the less densely populated communities. The Reconnaisance Report projected a population increase by 1995 of 11 percent from the 1975 figure. In view of the population stability experienced between 1975 and 1980, this 1995 projection of 281,000 is considered conservatively high.

Population data is included as Table 6 below.

TABLE 6
NEPONSET RIVER BASIN
POPULATION

Community	% Town Area Within Basin	% Population Change 1965 - 1975	Reconnaisance Report Projected % Population Change 1975 - 1995	Estimated 1980 Basin Total	% Population Change 1975 - 1980
Boston	15.6	3.5	-3.7	101,400	1.9
Canton	99.0	18.3	36.8	18,000	0.3
Dedham	28.2	1.1	3.9	7,150	-5.9
Dover	14.6	37.1	85.7	700	0
Foxboro	20.2	20.2	39.0	2,850	-3.4
Medfield	22.2	34.1	15.9	2,250	2.3
Milton	87.5	-1.8	4.0	22,650	-4.8
Norwood	100.0	8.1	27.1	29,711	-5.1
Quincy	16.7	5.0	4.2	14,150	-7.5
Randolph	15.6	34.4	24.2	4,400	-3.3
Sharon	64.9	19.8	40.3	8,850	0.6
Stoughton	44.4	30.6	28.5	11,850	3.9
Walpole	93.7	12.9	14.4	17,650	1.7
Westwood	65.3	15.6	29.0	8,650	-5.5
TOTAL		6.3	11.3	250,261	-0.9

(8) Cultural and Natural Resources

Over 40,000 acres in the study area is used as agricultural, forest, recreational or open space land. This does not even include wetland areas! This wealth of natural resources represents over half of the Neponset River Basin.

The primary existing resource along the river is the Neponset River Reservation comprising roughly 500 acres and administered by the MDC. This area is preserved for conservation purposes and not used for intense outdoor recreation. There are a number of areas along the river where opportunities exist for improving the riverfront environment and providing for outdoor recreation possibilities. Its utility as a recreational resource could be significantly enhanced if the water quality were improved.

The value of the area for human recreation and for wildlife enhancement lies in its diversity. Here the vegetation of inland New England is exemplified. The variety is exhilarating. Views of the Boston skyline contrast with the natural habitats to lend poignancy to the experience. For purposes of recreation, the area is nearly unique in the Boston area. Wildlife thrives here. The Fowl Meadow and its adjacent lands represent one of the few remaining habitats that is contiguously undisturbed and suitable for breeding of wildlife species no longer found in the Boston region. One of the largest fresh water wetland areas in the metropolitan area, the Fowl Meadow Reservation could be more widely used by conservation and education groups because of its unique resources.

Three major pond areas are related to the river: the Neponset Reservoir, its source in Foxborough; the Bird Ponds in Walpole; and Willett Pond in Walpole, Norwood and Westwood. All are artifically enlarged impoundment areas, privately controlled, and largely closed to public recreational opportunities that exist or could be created in the Neponset valley.

The Appalachian Mountain Club's Warner Trail, which starts at Canton Junction and ends in Blackstone, Rhode Island, is an example of a simple but popular kind of recreational facility which effectively makes use of limited land resources in a relatively well-developed area. However, the trail exists only by consent of the private landowners. It is in continual danger of encroachment by residential development.

The 5,700 total acres of the Blue Hills Reservation represents the greatest recreational resource in the area, a portion of which is in the Neponset watershed. Within the reservation are picnic areas, hiking trails, swimming at Houghton's Pond, bridle paths, golf, skiing, fishing and athletic fields. The value of this large recreational area to Boston cannot be overstated. Its size and wilderness-like quality, in such close proximity to downtown Boston, makes it unique and invaluable.

A number of water supply reservoirs in the watershed have outdoor recreation potential. Other lakes in the basin are not greatly used for public outdoor recreation except for Massapoag Lake.

Extensive filling of natural storage in wetlands has occurred in the past, and is continuing. The aesthetic appearance of the river banks is extremely poor, and the situation is worsening with increasing industrialization and development. Open space is becoming more and more scarce in the middle basin areas and is severely lacking in the lower basin.

Although the Neponset River Basin is rich in archaeological potential, there are few recorded sites in this section of eastern Massachusetts. Many prehistoric sites probably exist which have not yet been recorded. River banks were attractive areas for prehistoric settlement because of their good transportation and food resource potential.

Paul's Bridge, mentioned earlier under social environment, carries the Neponset Valley Parkway over the Neponset River at the outlet of the Fowl Meadow in Milton and is listed in the National Register of Historic Places. The Neponset River Basin was one of the first regions of this country to be settled. Many other historic buildings and sites, dating back to Colonial times, can be found within the watershed. Characteristic of most New England localities, townscapes feature a pleasant mix of historical features with modern development.

(9) Land Use

Several types of communities make up the Neponset River Basin. These range from the heavy urbanization of Boston to the rural residential character of Sharon.

Boston, Quincy, Dedham and Milton comprise the lower portion of the watershed. These communities are mostly urbanized and contain a wide variety of industrial and commercial interests. Boston has the most diversified economy in the basin. Quincy is a manufacturing city. Dedham and Milton contain more commercial and service oriented industries.

The middle portion of the basin - Westwood, Norwood and Canton - has a variety of industry. Development in Westwood and Norwood is heavy along Routes 1 and 1A, including both manufacturing and wholesale and retail trade. There is a concentration of industry along the East Branch through Canton, including the Plymouth Rubber Company.

Most of the industrial development in the upper watershed is in Walpole, concentrated along the Route 1-1A corridor. Foxboro has a large manufacturing community, but little is located within the study area.

The other towns in the basin are largely residential in character. Dover, Medfield, Sharon and Stoughton all contain little or no industrial

development and serve primarily as bedroom communities for the employment centers. The wetlands have been preserved in a more natural state due to the efforts of the Conservation Commissions in the watershed and the Metropolitan District Commission.

The Neponset is tidal for about 4 miles to the dam at the former Baker Chocolate Mill (the first chocolate mill in the country, now relocated). The Milton Yacht Club has taken advantage of safe moorings in this area and has developed, in cooperation with the town, an attractive small boat facility.

Between the dam and Boston's Mattapan Square, the Neponset is lost to all public use or enjoyment. Dredging for flood control purposes has confined the river to a trench with riprap sides. A chain link fence borders each side. There is one small Metropolitan District Commission playground off River Street.

From Mattapan Square to Paul's Bridge, the outlet of the Fowl Meadow, the Neponset has also been dredged and fenced. There has been little attempt over the years to create a pleasant relationship between the activities in Mattapan Square and the river. Truman Highway was constructed relatively recently, but no comprehensive site plan was adopted to provide imaginative and attractive landscaping, and development of recreational facilities. The view from the road is dreary and monotonous, and access to recreational facilities is difficult.

The central section of the Neponset itself, from Paul's Bridge to East Walpole, is largely undeveloped. Here the Neponset flows through the extensive Fowl Meadow marshes, which are partly owned by the Metropolitan District Commission. The slow, sluggish progress of the river through these marshes is characteristic of a large portion of the Neponset's flow. The Neponset is small and shallow, with its major visual impact in areas where it relates to these marshlands. Another significant wetland, the Cedar Swamp in Walpole, is part of the river's source.

The Neponset's natural sluggishness, coupled with its traditional use for disposal of industrial wastes, makes it the most critically polluted of all the rivers in metropolitan Boston. Dredging has not substantially improved the situation, and the river is more of a nuisance in residential areas than an asset. Pollution has severely curtailed all recreational uses for which the Neponset is potentially suitable.

D. The Without Condition

This section describes the most probable future condition for the Neponset River Basin, assuming no new Federal water resources projects in the study area. Alternative measures presented elsewhere in this report are assessed and evaluated by comparing the "with" to the "without project" condition.

(1) Development.

Population projections indicate that increases should be very moderate. Stability over the last five years has slowed down predicted population growth rate. The anticipated level of 281,000 watershed inhabitants, an increase of over 11 percent from 1975, is considered conservatively high.

However, developmental pressure can be expected to continue throughout the Neponset River Basin. An analysis of the number of housing units in the watershed shows an increase of over 11 percent between 1970 and 1980. Table 7 illustrates this urban migration to the suburbs by community. This increase compares to an actual decrease in population of nearly 8 percent over that same period!

TABLE 7
NEPONSET RIVER BASIN
HOUSING UNITS

Community	Estimated 1970 Units	Estimated 1980 Units	% Change
Boston	41250	43150	4.6
Canton	4650	5750	23.7
Dedham	2200	2350	6.8
Dover	200	200	0
Foxboro	800	1000	25.0
Medfield	550	700	27.3
Milton	7050	7500	6.4
Norwood	9321	10604	13.8
Quincy	4850	5750	18.6
Randolph	1150	1500	30.4
Sharon	2250	2850	26.7
Stoughton	2900	3950	36.2
Walpole	4550	5400	18.7
Westwood	2350	2750	17.0
TOTAL	84071	93454	11.2

The high pressure of further development of land resources will be felt especially in wetland areas, since they are often the easiest and cheapest parcels to acquire. Unless protected, more wetlands will undoubtedly be lost. Use of these low-lying and flat areas is frequently found more economical and/or expedient than building on other sites. Further urbanization will increase the potential for flood damage. Existing legislation calling for environmental review and permits for proposed development in wetlands has helped protect these areas so far.

Development has primarily been affecting the upper two-thirds of the basin in the more suburban communities. In light of current economic and

real estate conditions this trend can be expected to continue - but at a much slower rate. Population stability and enforcement of legislation already enacted will contribute to this situation.

Specific flood-prone areas identified include:

- Area downstream of Mother Brook through the urbanized sections of Dedham, Mattapan and Milton Lower Mills

- Mother Brook

- Readville Manor section of Dedham

- Industrial area adjacent to I-95 and Dedham - Canton Streets, including Shield's Chemical and Cumberland Farms

- Islington section of Westwood, adjacent to Purgatory Brook

- Pequid Brook at Turnpike Street (Rte. 138)

- Downstream portions of Massapoag Brook, affecting the heavily urbanized section of Canton

- Traphole Brook through East Walpole

- Industrial area between the USGS gaging station at Pleasant Street and Main Street (Rte 1A) thru Norwood and Walpole, and

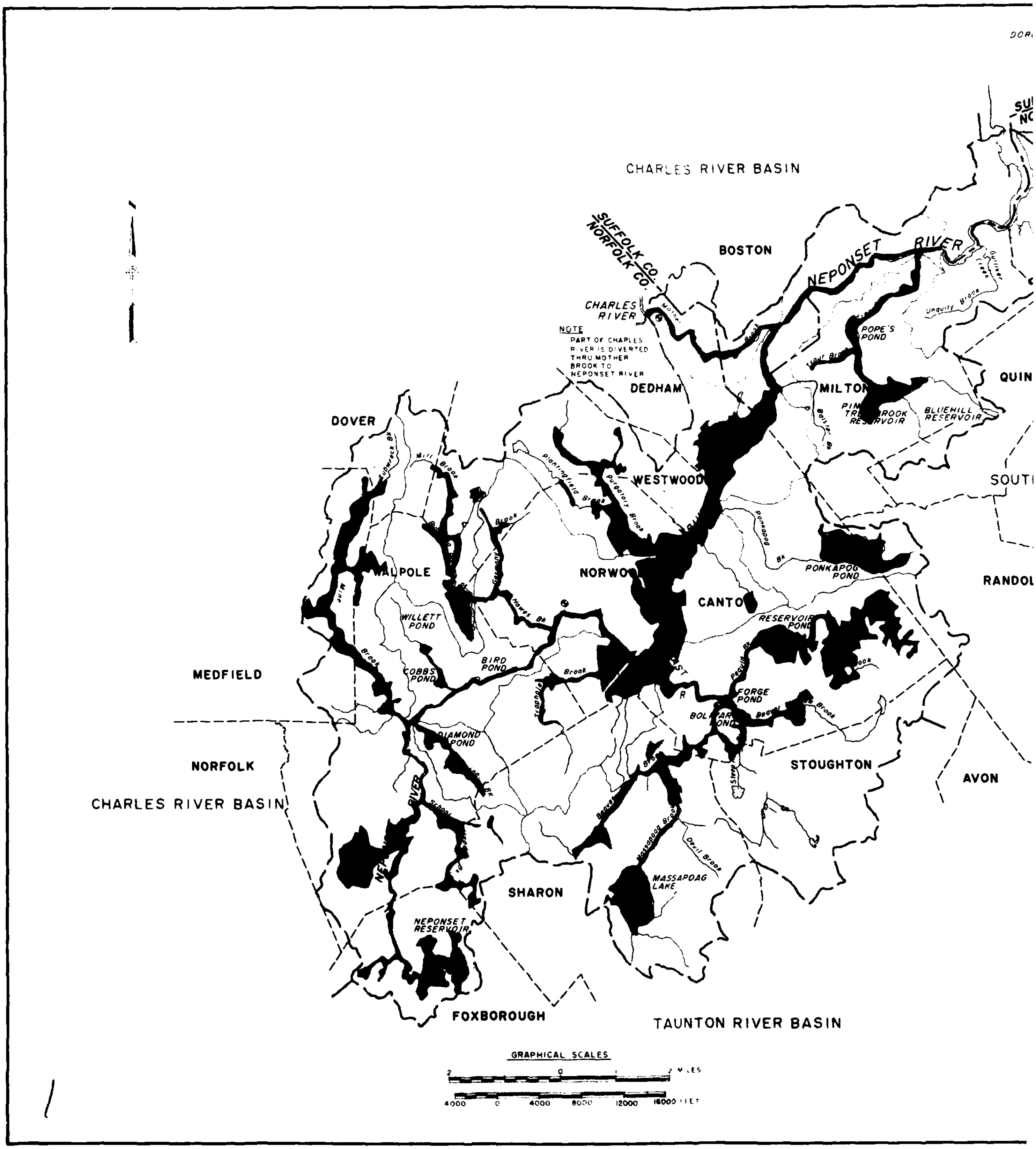
- Development downstream of Walpole Street (Rte 1A) along Hawes Brook.

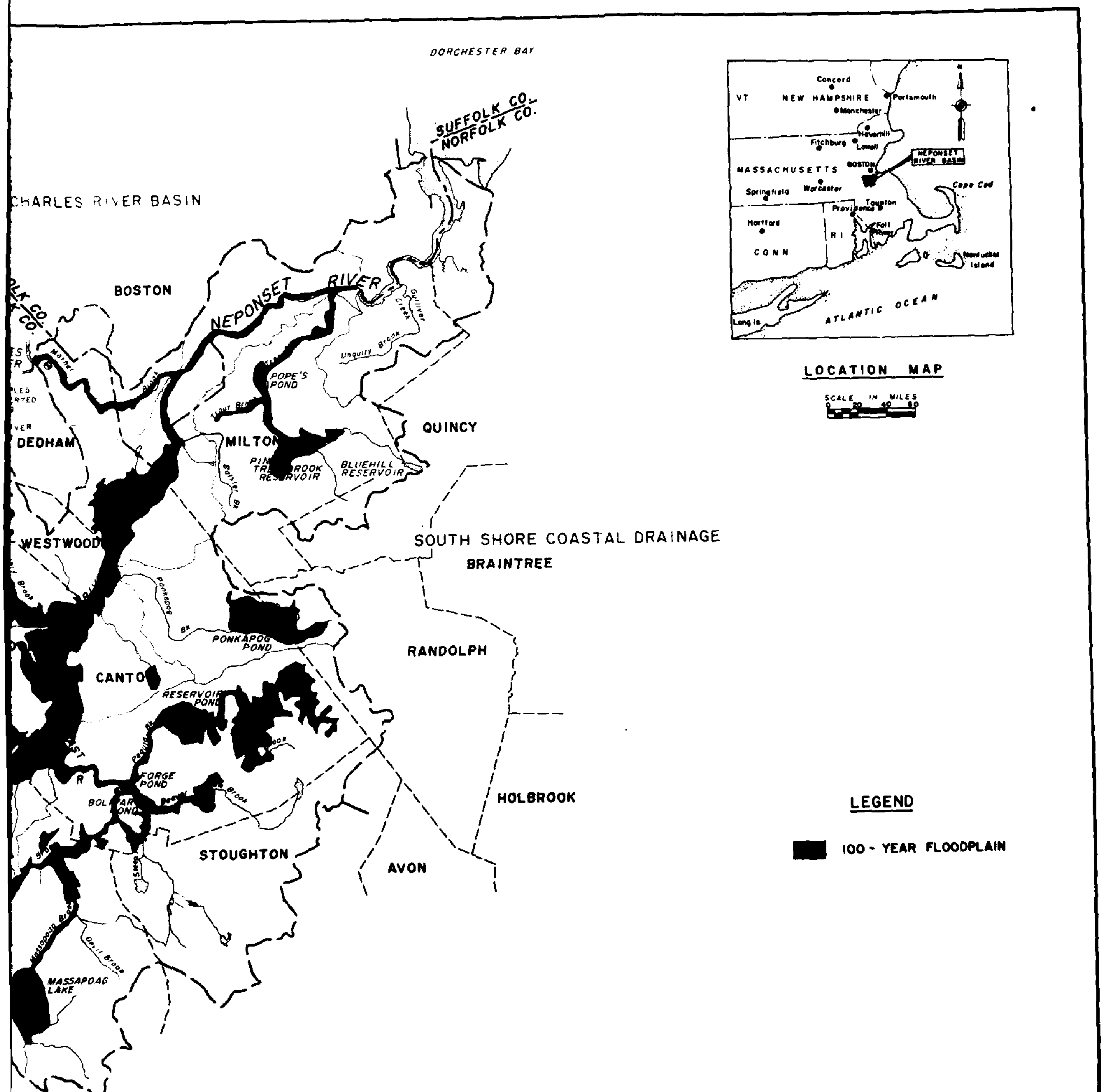
(2) Flood Potential.

The frequency of a flood may be expressed in terms of recurrence interval or probability of occurrence. The recurrence interval is the average interval of time within which a flood of a given magnitude will be repeated. Probability is virtually the reciprocal of the recurrence interval. When stated as a probability, the 100-year flood has 1 chance in 100 of occurring in any given year. Shown on Plate 3 is the 100-year flood plain for the Neponset River Basin.

The frequency with which a flood of given magnitude can be expected on the Neponset River at the Norwood USGS gaging station can be determined from streamflow records and other historical data. Gage data is available for the period 1940-present. Similar information can be compiled for the East Branch Neponset River at the USGS gage in Canton, Massachusetts.

As stated earlier, a flood equivalent to the March 1968 flood at Norwood has a recurrence interval of about 40 years. However, floods do not occur at regular intervals. A flood greater than the March 1968 flood had occurred in August 1955 -- only 13 years earlier! This latter flood


CHARLES RIVER BASIN
SUFFOLK CO.
NORFOLK CO.
BOSTON
NEPONSET RIVER
CHARLES RIVER
NOTE
PART OF CHARLES RIVER IS DIVERTED THRU MOTHER BROOK TO NEPONSET RIVER
DEDHAM
MILTON
POPE'S POND
BLUEHILL RESERVOIR
DOVER
WESTWOOD
WALPOLE
NORWOOD
CANTON
PONKAPOG POND
RANDOLPH
WILLETT POND
COBBS POND
BIRD POND
RESERVOIR POND
MEDFIELD
FORGE POND
DIAMOND POND
NORFOLK
STOUGHTON
AVON
CHARLES RIVER BASIN
SHARON
MASSAPOAG LAKE
NEPONSET RESERVOIR
FOXBOROUGH
TAUNTON RIVER BASIN
GRAPHICAL SCALES



WATER RESOURCES MANAGEMENT REPORT

NEPONSET RIVER BASIN

MASS.

FLOODING

PLATE 3

had been estimated to have a recurrence interval in excess of 100 years at Norwood. Table 8 summarizes expected flood damage by reach within the Neponset watershed annually and in the event of a 100-year storm.

TABLE 8
NEPONSET RIVER BASIN
ESTIMATED FLOOD DAMAGE

Zone	Recurring Losses ($1000 - 82 PL) Annual	100-Year
Walter Baker Dam to Canton Street	265	900
Canton Street to Traphole Bk	60	700
Traphole Bk to Diamond Bk	1,406	26,500
Diamond Bk to Neponset Res.	374	2,500
East Branch (Canton River)	14	80
TOTALS	2,119	30,680

The modifying effect of the natural storage is evidenced by the low amount of annual flood losses throughout the watershed. This, together with flood control works already in place, keep expected annual damages to only $2.1 million. A recurrence of the 1955 flood of record would result in over $31 million in losses.

Investigations of the flood plains of the Neponset River and its major tributaries have indicated little change in their limits since 1968. This can be attributed to the vast amounts of natural valley storage available within the basin which prohibit significant increases in flood stage. Development within the flood plains since 1968 has not reached the extent yet to measurably affect flooding.

Flood stage in the Neponset River Basin is highly sensitive to increases in floodflow. Peak discharges for the floods of 1955 and 1968 recorded by the USGS gaging station at Norwood on the Neponset (Tables 2 and 3) reveal a large increase in stage with only a small increment in flow. Flood elevations

jumped 4.2 feet with only 350 cfs of additional flow!

Nondevelopment of the flood plains is dependent upon enforcement of institutional constraints already legislated. If development occurs within the flood plains, then natural valley storage will be lost. If enough storage is lost, flood stages and potential damage will be increased. Areas that were previously dry will suffer flood losses. Existing flood-prone development will realize even more damage.

Development within the flood plains of the watershed has been checked, thus far, as a direct result of the Wetlands Protection Act (General Laws, Chapter 131, Section 40) enacted by the Commonwealth of Massachusetts in 1973, Section 404 of the Federal Water Pollution Control Act of 1972, and the National Flood Insurance Program. The Wetlands Protection Act allows the filling of wetlands only with the permission of the local conservation commission and the Commonwealth's Department of Environmental Quality Engineering. Compensatory storage is mandatory.

Section 404 of the Federal Water Pollution Control Act (FWPCA) established a permit program, administered by the Secretary of the Army acting through the U.S. Army Corps of Engineers, to regulate the discharge of dredged material and of those pollutants that comprise fill material into waters of the United States. Applications for permits are evaluated, including opportunity for public hearing and comment. Violations of the FWPCA without the required permit under Section 404 can result in civil fines.

The National Flood Insurance Program is conducted by the Federal Insurance Administration (FIA) under the direction of the Federal Emergency Management Agency (FEMA) -- formerly the Department of Housing and Urban Development, Flood Insurance Administration. The program provides local officials with a usable tool in protection of their flood plains. A flood-prone community, once on the regular program, must enact flood plain zoning in accordance with minimum guidelines established by FEMA. Failure to enact or enforce such legislation could be penalized by forfeiture of all Federal funding assistance.

Under the Flood Insurance Program, flood losses would be only partially covered as there are no existing provisions for compensating policyholders for nonphysical losses, such as expenses for lodging during dwelling rehabilitations or loss of income or profit while a commercial or manufacturing firm is temporarily closed. Other emergency expenses would include evacuation, food, clothing, restoration of public utilities and clean up operations. Undoubtedly, some residents would incur permanent losses in savings and irreplaceable personal belongings.

All of the communities within the Neponset River Basin are currently participating in, or expect to join, the regular program of flood insurance. Flood insurance alone merely indemnifies property owners for flood losses but does not reduce physical damages.

E. Problems, Needs And Opportunities

Estimated annual flood damages in the Neponset River Basin are $2.1 million. These losses, however, are scattered and are not concentrated in specific damage areas. In addition, flood damages are not expected to increase in the future.

This situation is the result of two actions-natural valley storage and flood protection measures implemented since 1955. These combine to reduce flood stages and keep losses to a minimum. Current institutions controlling the extent of future development are capable of maintaining this natural flood protection system. Legislation such as the Flood Insurance Program, the Inland Wetlands Protection Act and eventual ACEC designation for certain wetlands in the basin all contribute to protecting this natural valley storage.

Extensive investigations during this study found that there is no necessity for Federal participation in individual local protection projects. However, it was found that stricter enforcement of current legislation is needed to guard against unwise development in the flood plains and protect against loss of natural valley storage.

Communities throughout the Neponset River Basin do not have the means to implement and enforce this legislation. Adequate mapping delineating the extent of the wetlands, flood plains and development boundaries is lacking. Provision of this needed mapping would aid communities in controlling their own growth and destinies.

The Corps of Engineers seeks plans that provide solutions for existing flood problems and also offer the potential for reducing future flood damage within the study area. Wherever possible, these plans incorporate features that enhance the area's environmental quality. Based upon a preliminary assessment of the flood problems, needs and opportunities in the study area, the following problem and opportunity statements have been developed.

- Maintenance of minimum potential flood damage in the Neponset River Basin.

- Development of a flood plain management program which contributes to the environmental quality of the study area including enhancement of the recreational value of its natural resources.

- Enforcement of current legislation to guard against unwise development and to protect against loss of natural valley storage in the Neponset River Basin.

F. Planning Constraints

Planning efforts should not render ineffective the objectives of other planning agencies. Any plan should complement regional long range management plans. Formulation of a plan, for example, must be in agreement with the Commonwealth of Massachusetts' Coastal Zone Management Program or the environmental provisions of Section 404 of the 1972 Clean Water Act.

SECTION III

PRELIMINARY PLAN FORMULATION

SECTION III

PRELIMINARY PLAN FORMULATION

The formulation and analysis of preliminary plans is based, in part, on careful review of the existing situation and the problems, needs, and opportunities of the study area.

Alternative measures were investigated to meet the objective of preventing future flood damages. The probable associated social and environmental impacts were evaluated. Where applicable, community needs in other water resource areas such as recreation and water supply were considered in the assessment of alternatives. Each measure was investigated to a sufficient degree to determine its economic and engineering feasibility, the associated impacts resulting from its implementation, and the public attitudes toward it. This section describes the alternatives and plans that were studied and the iterative process used to screen them. A detailed description of specific measures is included as Appendix F.

A. MANAGEMENT MEASURES

Measures addressing flood damage prevention fall into two general categories. Some modify the extent of flooding by altering the natural environment. Others reduce flood damage vulnerability through floodplain regulations, flood insurance, floodproofing, relocation and/or acquisition.

Alternative Flood Damage Prevention Measures

Modify Extent	Reduce Vulnerability
Reservoirs	Floodproofing
	Flood Warning and Evacuation
Levees	Flood Plain Regulations
	Flood Insurance
	Public Acquisition of Flood
Walls	Plain Land

(1) Modify Extent

• Reservoirs - The function of a flood-mitigation reservoir is to store a portion of the flood flow in such a way as to minimize the flood peak at the point to be protected. In an ideal case, the reservoir is situated immediately upstream from the protected area and is operated to "cut-off" the flood peak. Water is released avoiding to the safe capacity downstream, and excess is stored to be released later.

A single reservoir cannot give equal protection to a number of damage sites located at differing distances downstream. Often several small reservoirs are preferable to a single large storage area. The wetlands in

the Neponset River Basin act as natural valley storage areas providing this similar flood mitigation function as manmade reservoirs. The scattered locations of these areas throughout the watershed protect potential damage sites downstream.

- Levees and Walls - With this measure walls or levees (small earth dikes) can be built around vulnerable structures or groups of structures. However, in this particular study, walls and levees were primarily considered where flood depths were 5 feet or less. This height limit was used because of the aesthetically unpleasing nature of having a high wall or levee placed around structures.

(2) Reduce Vulnerability

- Floodproofing. - This encompasses a body of techniques for preventing damages due to floods, requiring action both to structures and to building contents. It involves keeping water out, as well as reducing the effects of its entry. Such adjustments can be applied by the individual, or as part of a collective action, either when buildings are under construction or during remodeling of existing structures. They may be permanent or temporary.

Floodproofing, like other methods of preventing flood damages, has its limitations. It can generate a false sense of security and discourage the development of needed flood control and other actions. Indiscriminately used, it can tend to increase the uneconomical use of flood plains resulting from unregulated flood plain development. Each measure must be evaluated for its specific application in the reduction of flood damages. Only then can it be decided if that the particular measure is feasible, physically and economically.

Floodproofing measures can be classified into three broad categories. First are permanent measures which become an integral part of the structure or land surrounding it. Second are temporary or standby measures which are used only during floods, but which are constructed and made ready prior to any flood threat. Third are emergency measures which are carried out during flood situations in accordance with a predetermined plan. In recent years, floodproofing has come to be known as "non-structural," as distinguished from "structural" which is traditionally associated with major flood control works.

Nonstructural measures have an important role alongside traditional structural measures. Continued occupancy of developed flood plain sites, and even new development of such sites, may be necessary in some low-lying places - especially in certain urban areas where a shortage of land may offer no realistic alternative. Typical nonstructural measures include closures for openings (doors, windows, etc.), waterproof sealants for walls and floors, utility valves to prevent backflow of sewer and plumbing facilities, and sump pumps. Another technique is raising existing structures above flood levels.

Within an existing group of structures, damageable property can often be placed in a less vulnerable location or protected in-place. It is something every property owner can do to one degree or another. Furnaces and appliances can be protected by raising them off the floor. Damageable property can be moved from lower to higher floors, or other less flood-prone sites. Important mechanical and/or electrical equipment can be flood-proofed by inclosing them in a watertight utility cell or room.

Residual damage to both structure and contents will remain even when property is rearranged or protected. For these reasons, protection of property seems to be more seriously considered when other measures are either not physically or economically feasible, or the depth of flooding is relatively shallow.

Elimination of flood damages can also be accomplished by relocation of existing structures and/or contents. There are bascially two options for removing property to a location oustide the flood hazard area. One is to remove both structure and contents to a flood-free site; the second is to remove only the contents to a structure located outside the flood hazard area, and demolish or reuse the structure at the existing site. In each case, the purpose is to take advantage of the existing property in a manner compatible with the flood hazard.

• Flood Warning and Evacuation.—Flood forecasts, warning and evacuation is a strategy to reduce flood losses by charting out a plan of action to respond to a flood threat. The strategy includes:

- A system for early recognition and evaluation of potential floods.
- Procedures for issuance and dissemination of a flood warning.
- Arrangements for temporary evacuation of people and property.
- Provisions for installation of temporary protective measures.
- A means to maintain vital services.
- A plan for postflood reoccupation and economic recovery of the flooded area.

Flood warning is the critical link between forecast and response. An effective warning process will communicate the current and projected flood threat, reach all persons affected, account for the activities of the community at the time of the threat (day, night, weekday, weekend) and motivate persons to action. The decision to warn must be made by responsible agencies and officials in a competent manner to maintain credibility of future warnings.

An effective warning needs to be followed by an effective response. This means prompt and orderly evacuation of people and property. Actions that can facilitate this include:

- Establishment of rescue, medical and fire squads.
- Identification of rescue and emergency equipment.
- Identification of priorities for evacuation.
- Surveillance of evacuation to insure safety and protect property.

• Flood Plain Regulations.—Through proper land use regulation, flood plains can be managed to insure that their use is compatible with the severity of a flood hazard. Several means of regulation are available, including: zoning ordinances, subdivision regulations, and building and housing codes. Their purpose is to reduce flood losses by controlling the future and existing uses of flood plain lands.

Zoning regulates the use of structures and land, the height and bulk of structures, and the size of lots and density of use. It is usually based upon some broad land use plans to guide the growth of the community. Subdivision regulations guide the division of large parcels of land into smaller lots for the purpose of sale for building development. Subdivision regulations with special reference to flood hazards often (1) require installation of adequate drainage facilities, (2) require filling of a portion of each lot to provide a safe building site at elevation above selected flood heights, and (3) require the placement of streets and public utilities above a selected flood protection elevation. Building and Housing Codes neither regulates where development takes place nor the type of development, but rather specify building design and materials.

Adoption, administration, and enforcement are essential steps for successful flood plain regulation programs.

• Flood Insurance.—Flood insurance is not really a flood damage prevention measure as it does not reduce damages; rather it provides protection from financial loss suffered during a flood. The National Flood Insurance Program was created by Congress in an attempt to reduce, through more careful planning, the annual flood losses and to make flood insurance protection available to property owners. Prior to this program, the response to flood disaster was limited to the building of flood control works and providing disaster relief to flood victims. Insurance companies would not sell flood coverage to property owners, and new construction would often overlook new flood protection techniques. The insurance program, however, did not come about overnight; it took several attempts and 17 years before the bill was approved and put into effect.

Flood insurance is an option for all owners of existing buildings in a community identified as flood-prone, yet it is compulsory for all buyers of existing or new buildings in the Federal Emergency Management Agency (FEMA) designated 100-year flood plain where Federally insured mortgages or mortgages through Federally connected banks are involved.

In order to qualify, a community must adopt preliminary flood plain management measures including floodproofing for all proposed construction or other development. They must be reviewed to assure that sites are reasonably free from flooding. All structures in flood-prone areas must be properly anchored and made of materials that will minimize flood damage; new subdivisions must have adequate drainage; and new or replacement utility systems must be located to prevent flood loss.

· Public Acquisition of Flood Plain Land.— Public control over the flood plain may be obtained by purchasing the title or some lesser rights such as development or public access rights. Acquisition of the title is better suited for undeveloped or sparsely developed land in the flood plain. It is a very desirable means, however, of protecting and/or providing public access for environmental, wildlife protection, public open space and recreation or other purposes.

B. PLANS OF OTHERS.

A variety of Commonwealth of Massachusetts comprehensive plans and programs have direct bearing on water and related land uses in the study area. Those relevant to this study are described here.

. Statewide Comprehensive Outdoor Recreation Plan (SCORP) prepared by the Department of Environment Management (DEM), and recommends that recreational needs be met where demand is greatest and supply most deficient, and that priority be placed on satisfying the needs for the most widely demanded recreational activity. The plan identifies swimming as the most popular recreational activity and finds that urban areas, particularly the greater Boston area, have the highest need for new recreational facilities.

· State Growth Policy Plan, prepared by the Office of State Planning (OSP), recommends that new growth and development be channeled to existing urban centers or to regional development centers, and that State actions, particularly State programs of public investments, adhere to the policy and support urban development.

· Coastal Zone Management Program (CZM) offers technical assistance to communities, provides for Federal consistency with policies, and above all, sets a high priority on placing the State's regulatory and management programs in order and making them work in a more asured, timely and consistent manner. The Massachusetts CZM program protects the coastline's natural resources and insures that the environmental and economic values of the coastal zone will be sustained, and even enhanced.

C. PLAN FORMULATION

During the course of the study, preliminary plans were evaluated for feasibility in satisfying flood protection needs and economic justification. These plans were formulated to decide if further studies should continue.

Before any alternative plan could be developed, it was necessary to establish some criteria to assess the effect of the existing inland wetlands. The wetlands had to be evaluated to determine the amount of natural storage provided. A determination was made as to the adequacy of this storage in preventing flood damage. The potential holding capacity of these wetlands dictates the level of protection provided, and is related to the volume of floodwater that can be stored.

Several factors are involved in determining the natural effectiveness of an inland wetland in the control of a drainage area. As outlined above, the first of these is the size, shape and total storage capacity. Secondly, and of equal importance, is the physical location in the basin. Unless most wetland areas in a basin are located upstream of existing or potential damage areas, they have little effectiveness in mitigating floodflow. Also to be considered is the topography of the watershed. The topography controls the present and future runoff conditions. Steep topography will result in a higher rate of runoff than terrain more gentle in character. Thus a swamp in a predominately steep area is more valuable than an equal size swamp in a gently sloped area.

Wetlands located along major water courses are particularly valuable due to their dual function as both floodplains and as wetlands. During flood conditions, these wetlands act as both natural storage areas and as an increased channel area to pass floodflows. Encroachment of these wetlands will usually result in greater potential losses than development of an equivalent wetland area in the upper reaches of a drainage area.

Natural valley storage in the neighboring Charles River watershed had been found to be an effective flood control measure. A damage survey throughout the study area was conducted. Detailed topographic mapping was obtained to determine and delineate the characteristics of the Neponset River Basin. An institutional analysis was performed. Further urbanization can only increase the flooding potential. A complete picture of flooding within the watershed combined with experience gained from flood damage reduction practices in other similar watersheds helped formulate and evaluate effective flood plain management program for the Neponset River Basin.

SECTION IV

DESCRIPTION, ASSESSMENT AND EVALUATION OF PRELIMINARY PLANS

DESCRIPTION, ASSESSMENT AND EVALUATION OF PRELIMINARY PLANS

Following are those alternatives that were investigated for the purpose of meeting one or all of the objectives of this study.

Plan A would provide flood damage prevention by preservation of natural valley storage areas within the Neponset River Basin. Plan B would utilize nonstructural measures, and Plan C considers structural local protection projects for specific damage sites in the watershed.

A. Plan A - Natural Valley Storage

This flood plain management plan consists of preservation of key wetland areas in the Neponset River Basin which retard flood flow. These wetlands act as a reservoir system providing natural valley storage retaining and de-synchronizing flood flows. Without this control system serious flood damages would occur.

Fourteen areas were selected as having regional significance in lowering flood peaks. These areas are scattered throughout the watershed. The smallest area is Pine Tree Brook Reservoir (95 acres) in Milton, Massachusetts. The largest, and most important, is the Fowl Meadow (3100 acres) bordering the Neponset River through Boston, Milton, Westwood, Dedham, Norwood, Canton and Sharon, Massachusetts. Only four of the areas are directly on the Neponset main stem. The others are located on tributary streams to the Neponset River.

These natural valley storage areas were analyzed hydrologically and hydraulically to determine their specific effect on flood flows. This analysis is included as Appendix C and concluded the following.

Before the Fowl Meadow storage reach in the Neponset can discharge a certain magnitude of flow it must be of sufficient depth. This required increase in stage results in significant temporary retention storage which greatly attenuates peak flood flows. Depths of temporary surcharge storage were found to generally range from 2 to 5 feet. It was further determined that the storage provided about a 25 percent reduction in flow.

The large Fowl Meadow storage, including Purgatory Brook, has a surface area in the realm of 3,500 acres. Flood analysis indicated generally 5 to 8 feet of temporary surcharge storage over this area providing about 15,000 to 30,000 plus acre-feet of storage. This provides a 60 to 70 percent reduction between peak inflow and outflow from the reach!

Loss of storage in the Fowl Meadow and other wetland areas in the watershed would have a significant effect on peak flows downstream, but it would also affect flood levels and associated damages in their peripheral

areas. It is for this reason that periodic flood storage in the meadow and other natural valley storage areas should be planned and provided for with the peripheral areas developed accordingly.

To minimize the effects of urbanization, these wetlands and certain key waterway openings must be maintained in their present condition. A form of control is imperative to this end. This can be accomplished institutionally by the enforcement of restrictive zoning, building codes, tax incentives, flood insurance, etc. Preservation of the natural valley storage areas may also be ensured by public acquisition, although generally costlier than strict legislative restrictions.

There are pressures for more intense development in these peripheral areas posing a continuing need for planned management and development with due consideration of the watershed's hydrologic character. Existing state and Federal regulations, as well as local ordinances, should be employed throughout the basin for wise management of natural wetland and other detention storage areas. Particular attention should be given to the adjacent flood plain properties.

• Impacts - Preservation of natural valley storage areas is essentially a nonphysical, nonstructural flood protection measure. Significant flooding is prevented by attnuation of peak flows. Nuisance flooding may still occur. This plan is environmentally sound. In addition, non-development of the wetland areas in the watershed would provide the study area with needed recreational resources and open space.

Institutional analysis indicates the existence of legislation which could be used to implement this plan. Its effectiveness is dependent upon the support and enforcement by community officials. Mapping developed as part of this study would be provided to local officials to help them interpret and enforce legislation affecting development.

A cost estimate for implementation of this plan was never compiled due to the findings of the institutional analysis. Preservation of natural valley storage by acquisition or easement would undoubtedly be very expensive. A similar program in the Charles River Basin, neighboring the Neponset watershed, is approximated at $9 million plus for protection of about 9000 acres. Strict enforcement of current legislation would obviously not cost local interests nearly as much.

B. Plan B - Nonstructural.

The nonstructural plan considers the following measures for protection against the 100-year flood.

- raising existing homes and/or utilities above flood level
- construction of small walls around certain structures
- closures for windows of commercial buildings
- implementation of an early warning and evacuation plan

A breakdown of the typical feasibility and total cost of each nonstructural measure is given below. An individual analysis would have to be undertaken to determine what measures would most benefit each structure. It should be re-emphasized that nonstructural alternatives do not alter the actual flooding experienced, but only modify the extent of damages. A more detailed description of nonstructural flood protection techniques is included as an appendix.

TABLE 9
TYPICAL NONSTRUCTURAL COSTS

Measure	Cost
Walls (3 ft high)	$ 700/LF
Levees (3 ft high)	140/LF
Closures	90/SF
Raising (8 ft)	31,000/HOME
Utility Cell	14,550/HOME
Utility Room	8,500/HOME
Early Warning and Evacuation	

· Impacts - Measures such as elevating homes and other floodproofing techniques are all considered nonstructural flood protection. Flooding is not prevented and disruption to community activities will still occur when streets are flooded and emergency services are restricted. An early warning and evacuation system has a short implementation time and is dependent upon the support and assistance of community officials. Other environmental concerns under this plan are minimal.

C. Plan C - Structural Local Protection

Potential damages were found to be scattered, with only a few specific damage centers. Local protection measures were investigated for these areas. A damage survey combined with knowledge of traditional costs of protective measures indicated that there were no sites warranting further investigation.

· Impacts - Flooding is prevented and activities can continue during flood conditions. Environmental concerns include temporary construction along with permanent impacts at the project site. Additional development is usually encouraged due to the protection provided. A cost sharing arrangement with local interests would have to be agreed upon.

D. Comparison of Plans.

A plan calling for preservation of natural valley storage (Plan A) to control flooding is clearly environmentally sound. Land acquisition is a very expensive measure to implement. However, it was found that enforcement of existing legislation would provide the same end at a cost

that is negligible. In addition, nondevelopment of these wetland areas would provide the study area with needed recreational resources and open space. This plan is cost effective.

A program of nonstructural flood protective measures (Plan B) such as floodproofing and raising of buildings only reduces the vulnerability to flood damage. Its effectiveness is usually dependent upon local action during flood conditions. Flooding remains and will increase with unchecked urban development. Environmental concerns are generally minimal, being local and temporary by nature. The usual construction impacts along with any aesthetic considerations are involved with this alternative. Cost-sharing arrangements with local interests would have to be agreed upon.

No structural local protection project (Plan C) were found to warrant further evaluation.

All the plans reduce flood damage. Plans A and B meet the objectives of this study. Plan A provides protection that is not dependent on human action during flood conditions, as well as, a management plan controlling future development in the flood plains of the watershed. This plan can be implemented at little cost to the Federal and local governments.

Plan B's effectiveness is normally dependent on human action during flood conditions. The level of development is not affected and flooding remains. In addition, costs would have to be shared by Federal and non-Federal interests.

E. Public Views.

Another aspect of the Neponset Flood Plain Management study involved communication with citizens who are affected by flooding. Extensive coordination was maintained with the Neponset Conservation Association (NCA) - the leading citizens' group concerning water resources planning in the study area. Their letter of endorsement of Corps' efforts to date follows.

Both the NCA and the Commonwealth of Massachusetts support nonstructural solutions to flood problems. In fact, the NCA has diligently pursued the ACEC (Area of Critical Environmental Concern) designation for certain wetlands within the Neponset River Basin. This would provide another layer of institutional protection of natural valley storage and is a component of Plan A.

SECTION V

STUDY MANAGEMENT

SECTION V
STUDY MANAGEMENT

Strong study management was needed to assure a sound and orderly planning process. In order to achieve this, study management was provided by the Corps of Engineers. The Neponset Conservation Association assisted in study coordination and plan formulation.

The Commander and Division Engineer, New England Division, US Army Corps of Engineers, had overall responsibility for the conduct and management of the Neponset Flood Plain Management Study. A multidisciplinary unit made up the study team. Study coordination was accomplished by the Planning Division, Basin Management Branch, augmented by expertise provided by other offices in the Division organization. The day-to-day operation of the study was the responsibility of the study manager.

The Neponset Conservation Association advised on programs and major work items and coordinated its respective interests, policies and programs with the study.

A. Public Involvement

(1) General.

Public involvement in all phases of the study process assists planners in defining study objectives and priorities, and develops channels through which ideas and information can be shared by all participants. During Stage 2 the public involvement program emphasized nonstructural arrangements to meet the objectives of the study. The results of detailed alternative studies were presented to the public and the communities involved.

In the broadest sense, the public consisted of all non-Corps of Engineers entities: Federal, State, local and regional agencies as well as public and private organizations and the general public. The public was categorized into three distinct, yet related, groups consisting of the governmental sector, special interest groups and the general public.

The primary objective of the public participation program was to provide continuous two-way communication to involve the public in the overall planning process. By keeping the public informed about the study's progress, interested persons could assist in the making of decisions affecting them. Major decisions made throughout the study were based upon the expressed needs and objectives of all local, state and regional officials and members of the general public.

The public involvement program of the Neponset Flood Plain Management Study was closely coordinated with other water resources planning efforts

being conducted by local, regional, State, and Federal agencies. The Corps, in cooperation with the Commonwealth of Massachusetts, conducted the public involvement activities to insure that the public's interests and desires were considered and acted upon.

The program was designed to provide information which will assist the public in the definition of water and related land resources problems within the study area and the concerns, objectives and priorities of its citizens so they may effectively participate in the study. In addition, public involvement contributed toward this study being flexible and able to be modified in response to needs as they were identified. A system of coordination between this study and water resources planning efforts of other Federal, State, regional and local agencies was established.

(2) Interactions.

The plan was structured to provide the public with a better understanding of the entire planning process as the study progressed from one stage to the next. During problem identification, public involvement efforts were directed toward information and collection of data to assist in the identification and description of flood protection problems, concerns and opportunities. Information concerning the public's environmental, social and economic desires were solicited.

Public involvement aided in asuring that the alternatives developed addressed the full range of problems and concerns as perceived by the public in response to stated planning objectives. Informing the public and obtaining their feedback about the various technological and managerial measures available for meeting stated objectives was our desire during this phase.

Specific work tasks accomplished during the formulation of alternatives included dissemination and presentation of materials to various groups and organizations and analysis and evaluation of the program.

Public involvement during impact assessment concentrated on identification and measurement of the impacts of flood protection plans as they relate to the entire study area and the general public. During the impact asessment phase information was obtained about interest groups. The elements and impacts of each alternative plan were evaluated with consideration to the significance of impacts to each affected public. Specific public involvement objectives during the evaluation of alternative plans included determining the publics' acceptability of alternative plans and then ranking them in terms of their contribution to planning objectives.

In addition to public forums, both progress and informational meetings were held to maintain close cooperation of study elements with all study participants. The progress-type meeting were a working session of the

workshop committee. This procedure enabled study participants to effectively evaluate detailed plans by focusing attention on specific problem areas, and analyzing the legal and institutional framework required for effective plan implementation.

B. Schedule

After coordination of this report, Stage 2 of the Neponset Flood Plain Management Study will be complete. Stage 3 will not be initiated due to the lack of opportunity for Federal participation.

Due to this report's negative recommendation, stage 3 schedule and costs have not been developed. There appears to be no necessity for further Federal involvement in flood damage reduction in the Neponset River Basin at this time.

Project Management has used the Resources Allocation/Project Management (RA/PM) System. Output from this analysis was used to establish the study schedule and budget.

TABLE 10
NEPONSET FLOOD PLAIN MANAGEMENT
STUDY MILESTONES

Planning Milestone	Description	Scheduled	Completed
Stage 1			
01	Study Initiation		March 78
02	Approval of Reconnaissance Report		Dec 79
Stage 2			
03	Submission of Stage 2 Documentation to OCE		Feb 82
04	Issue Resolution Conference	April 82	
05	Completion of Action on MFR	June 82	

SECTION VI

CONCLUSIONS AND RECOMMENDATIONS

SECTION VI
CONCLUSIONS AND RECOMMENDATIONS

Analysis of alternative flood plain management measures during Stage 2 investigations for the Neponset River Basin indicates that structural protection is not economically feasible for any individual damage site. Below are concise statements relating some of the conclusions developed during the study:

A. Existing Condition

- Natural valley storage reduces flood damage in the watershed significantly.

- The extent of the flood plains has not changed significantly since the last major flood event in 1968.

B. Without Condition

- Flood damage is not expected to increase in the future. Existing legislation, if enforced, can effectively keep flood damage at a minimum.

C. Alternatives

- Structural local protection measures for any individual damage site referenced earlier is not economically justified.

- Acquisition of natural valley storage areas throughout the Neponset River Basin is not required becausc of the existence of legislation capable of controlling the extent of future development.

- Provision of data, including detailed mapping, compiled during this study will contribute to effective enforcement of current institutional measures.

- Some potential damages may be reduced by other nonstructural measures taken by individual owners.

TABLE 11

Impacts Chart
Flood Damage Reduction Alternatives

IMPACTS	A NATURAL VALLEY STORAGE	B NON-STRUCTURAL MEASURES	C STRUCTURAL LOCAL PROTECTION
	(+ Beneficial, - Adverse, * Non Applicable)		
1. Relatively short implementation time.	+	+	*
2. Additional study would be required.	*	-	-
3. Temporary inconvenience to owners during necessary construction work.	*	-	-
4. Potential loss of local local tax revenues.	-	*	*
5. Protection of recreational and water supply resources.	+	*	*
6. Reduction of flood losses, disaster-related costs, and loss of life.	+	+	+
7. Economically justified.	+	+	-
8. Continuance of flood threat as under the without condition.	—	-	+
9. Possibility of encouragement of additional development.	+	*	-

D. Recommendations

I recommend that this Stage 2 document for the Neponset Flood Plain Management Study conclude investigations in the watershed, as there is no necessity for Federal participation in flood damage reduction measures in the basin at this time.

It was found that existing legislation, if more strictly enforced, is capable of keeping flood losses within acceptable limits. This can be accomplished at the non-federal level, as described in Plan A. Mapping and other engineering analyses completed as part of this study effort will be made available to local communities to aid them in implementing flood plain encroachment laws and guide the direction of future development.

Individual flood damage sites may, at some future point, qualify for protective measures because of increased runoff associated with continuing urban development within the basin, future flood events, or changes in economic and environmental priorities. The preliminary work of this study provides a baseline of data for additional analysis, if required.

I further recommend that individuals who experience flood damage be encouraged to purchase flood insurance and be advised of individual nonstructural measures that can be implemented, as described in Plan B.

APPENDICES

APPENDIX A

PRIOR STUDIES
AND
REPORTS

PRIOR STUDIES AND REPORTS

NEPONSET RIVER BASIN

A. INTERAGENCY

1. The Massachusetts Water Resources Study was initiated by a cooperative agreement between the U.S. Department of Agriculture (USDA) and the Massachusetts Water Resources Commission (MWRC). This water and related land resources study, published in 1978, provided data to the Commission for use in the preparation of an overall State Water and Related Land Resources Plan.

Public Law 83-566 (68 stat. 666, as amended), the Watershed Protection and Flood Prevention Act, authorized participation by three USDA agencies: the Forest Service; Economics, Statistics and Cooperatives Service; and the Soil Conservation Service. The Massachusetts Divisions of Water Resources, Forests and Parks, Fisheries and Wildlife, and Water Pollution Control, and the Massachusetts Department of Agriculture were the State agencies most actively involved in this study.

The Neponset River Basin was included in the Coastal Region volume of this study. Although data was presented according to individual drainage areas, conclusions and recommendations were made on a regional basis. Concerning inland flooding and wetlands, the study concluded that: "As a result of the flood insurance program and the growing tendency to adopt flood plain management measures, future flood plain development is expected to be highly restricted. As a consequence, flood damage is not expected to increase significantly . . . Flood plain regulations and flood insurance will not reduce flood damage to existing development. There is a need to develop alternatives to reduce flood damage in the region to an acceptable level."

The study also reported that "ongoing wetlands programs, especially Massachusetts pioneer wetlands legislation, will go far in protecting wetlands from harmful alteration." Increased public acquisition of wetlands, acceleration of the Inland Wetlands Restriction Program, and expanded conservancy zoning of wetlands were recommended.

2. EMMA - In March 1976 an intensive interagency study addressing methods for combating pollution in the Boston Harbor-Eastern Massachusetts Metropolitan Area (EMMA) was completed under the direction of the Technical Subcommittee on Boston Harbor, chaired by the MDC. Other Federal, State and regional agencies who participated in the study as members of the Technical Subcommittee were the U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, Massachusetts Department of Environmental Quality Engineering, Massachusetss Office of State Planning, Massachusetts Division of Water Pollution Control and the Metropolitan Area Planning Council (MAPC). A Citizens' Advisory Committee acted as an advisor to the Technical Subcommittee.

Authorization was founded in the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500), which mandate not only cleaner waters but also unified management of this precious resource.

In 1972 the Committees on Public Works of the U.S. Senate and U.S. House of Representatives passed similar resolutions requesting the Secretary of the Army, acting through the Corps of Engineers, to undertake a joint study with the Commonwealth of Massachusetts to recommend wastewater management improvements and alternatives for the Boston metropolitan area. As a result of these resolutions, an agreement was signed by the Corps of Engineers and the Commonwealth of Massachusetts to undertake jointly a planning effort for wastewater management in the Boston metropolitan area. Through this agreement, the Corps of Engineers became a co-participant with the MDC in this study.

Recommendations directly related to the Neponset River Basin included the construction of an advanced treatment facility with a 25 mgd capacity in the Canton-Norwood area, serving the towns of Canton, Norwood, Sharon, Stoughton and Walpole. This would augment low flow. Although the EMMA study primarily dealt with water quality issues, its value to this flood plain management study of the Neponset River watershed lies in its planning data. Much information was, and can be, drawn upon -- eliminating duplication of effort.

3. SENE - Section 201 (b) (2) of the 1965 Water Resources Planning Act (PL 89-80) authorized the New England River Basins Commission (NERBC) to prepare a comprehensive joint plan for Federal, State, interstate, local and nongovernmental development of water and related resources. NERBC approved an initial program on 14 May 1968, placing first priority on implementation of its responsibilities for comprehensive planning. In January 1971 Federal funds were made available to NERBC, resulting in the Southeastern New England Water and Related Land Resources Study (SENE), completed in 1975. SENE recommended: "The Corps of Engineers in close cooperation with State, regional and local officials, should develop a comprehensive flood plain management plan for the Neponset watershed."

The goal of SENE was to find ways to accommodate the sometimes conflicting demands for conservation and growth. The conclusion of SENE was that there is room for this growth. But, ". . . if the patterns of growth continue as they have in the past decade, the natural resource amenities which stimulated it in the first place will be destroyed. There will be real, even agonizing, local conflicts over specific uses of certain resources. And a degree of control over certain types of development and the use of certain fragile resources will be necessary. But, overall, we have both the land and the technical and political means to provide both sites and resources for job-producing economic activities and still have an attractive environment in which to live."

Specific recommendations included protection of critical environmental areas -- areas too fragile to support any development, or whose development might constitute a hazard to public health and safety. Areas cited were water bodies, well sites, inland and coastal wetlands, flood plains and unique natural and cultural sites.

SENE's key recommendations for flood damage reduction were:

- Preparation of comprehensive flood plain management programs
- Full participation in the National Flood Insurance Program
- Restriction of adverse development, or redevelopment, in inland or coastal flood prone areas and coastal erosion areas
- Strengthening of State wetlands legislation
- Acquisition of key wetlands and flood plains
- Selective construction of flood control projects

Also noted was that "the region's network of wetlands and flood plains provide an ideal opportunity to use nonstructural measures, established at the local level under State guidance, to reduce damages."

SENE reported that despite preventive measures already taken in the basin, future problems may exist if development is allowed to proceed unchecked. Encroachment of the upstream flood plain areas will result in increased river heights in the highly developed areas of Dedham, Hyde Park, Mattapan and Milton. This will cause

future flood damages to become more severe from storms equivalent to those that now do not cause severe damage.

4. The North Atlantic Regional Water Resources Study (NAR) was authorized by the Water Resources Act of 1965. Its objective was to provide broad scale analyses of water and related land resource problems within the region, and furnish general appraisals of the probable nature, extent and timing of measures for their solution.

The Departments of Agriculture; Health, Education and Welfare; and Interior; the Federal Power Commission and the Delaware River Basin Commission participated with the Department of the Army, Corps of Engineers, who chaired the study. The Departments of Commerce and Housing and Urban Development joined the Study after the first coordination meeting in January 1966. The Department of Transportation, the Environmental Protection Agency and the New England River Basins Commission were added at a later time.

Submitted in June 1972, the NAR recommended improvements in conservation and land use programs and acceleration of flood plain management programs.

5. NENYIAC - An invaluable document is the report of the *New England-New York Inter-Agency Committee (NENYIAC) on The* Resources of the New England-New York Region; Part Two, Chapter XVI, Massachusetts Coastal Area. Authorized by a directive contained in a Presidential Letter of October 9, 1950 and published in 1955, NENYIAC cited past flooding within the Neponset and the potential of development of the Fowl Meadow. NENYIAC, however, presents information prior to Hurricane Diane in 1955, thus invalidating certain data.

B. FEDERAL

1. Corps of Engineers, New England Division - To date, six studies have been accomplished under authority contained in Section 205 of the 1948 Flood Control Act, as amended. Section 205 provides authority to the Chief of Engineers to construct small flood control projects that have not already been specifically authorized by Congress. Projects must be complete within themselves and economically justified. Federal costs are generally limited to $2 million.

a. Canton Local Protection - During 1962-1963, the New England Division, Corps of Engineers constructed a small flood control project along the East Branch Neponset River (Canton River) at the Plymouth Rubber Company located in Canton. The

Canton local protection works was authorized by Section 205 at a Federal cost of $180,700. The improvement provides flood protection for the town's largest industry and several commercial firms along the town's main street. Since completion, the project has prevented more than $2.5 million in damages.

b. Massapoag Brook - More recently, an investigation of other flood problem areas in Canton was completed in November 1969, under the authority of Section 205, to determine the need and feasibility of providing additional local flood protection along Massapoag Brook. The study could not recommend Federal participation in a local protection project. Analyses of various alternative solutions indicated insufficient economic justification for approval.

However, during Operation Foresight (March 1969), the Corps was able to perform emergency flood protection along Massapoag Brook. The project consisted of channel clearing from Walnut Street to Bolivar Street and dredging from Bolivar Street to Forge Pond, a total distance of about 1,700 feet. The primary purpose was to reduce flooding by removing restrictions that would impede flood-flows and thus reduce flooding.

c. Norwood - Under the provisions of Section 205, a study of reconnaissance scope was made in 1970 to determine the need and feasibility of a local protection project along the Neponset River in Norwood, Massachusetts. In March 1968 the industrial complex along the Neponset, including New London Mills and Bird and Son Company, was inundated with flood depths up to 40 inches. As in the case of Massapoag Brook, analyses of various alternative solutions could not recommend Federal participation due to insufficient economic justification.

d. Readville and East Walpole - Other studies performed under authority granted by Section 205 included investigations of the Readville section of Dedham in 1972 and portions of East Walpole in 1976. Both flooding problems were found to be caused by inadequate local drainage, and thus were outside Corps authority.

e. Traphole Brook - An investigation was made in 1977 under the provisions of Section 205 to determine the need and feasibility of local flood control improvements along Traphole Brook in Walpole. In recent years extensive residential and commercial development in the upper watershed have increased the rate and intensity of runoff into the downstream reaches of the brook. The Corps concluded that in addition to inadequate channel capacities in the lower watershed, undersized culverts and bridges

contributed to the flood problem However, there was a lack of economic justification to permit Corps of Engineers participation.

2. Federal Emergency Management Agency, Federal Insurance Administration - Flood Insurance Studies (FIS) are authorized to investigate the existence and severity of flood hazards within designated floodprone communities, and to aid in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973, as amended. FIS's are also meant for use by local and regional planners in their efforts to promote sound land use and flood plain development. The Department of Housing and Urban Development, Flood Insurance Administration (HUD/FIA), which is now the Federal Emergency Management Agency, Federal Insurance Administration (FEMA/FIA), is charged with the responsibility of coordinating the Flood Insurance Program. One of the more meaningful impacts of the program is mandatory adherence to minimum guidelines set by FEMA for the development of flood plain lands. The penalty for noncompliance by those municipalities designated as flood prone by FEMA is forfeiture of all Federal funding assistance.

The Flood Insurance Program is meant to provide new construction with reasonable protection from flood damage by prudent management of the flood plain and to protect residents of flood-prone areas against financial loss from flooding. This protection was previously unavailable at affordable rates. A community qualifies for the program in two separate phases -- the Emergency and Regular Programs.

Under the initial Emergency phase, limited amounts of flood insurance becomes available to local property owners. At this stage FEMA provides the community with a Flood Hazard Boundary Map (FHBM) that outlines the flood-prone areas within the community. Subsidized rates are charged for all structures regardless of their flood risk.

Under the Regular Program, the full limits of flood insurance coverage become available locally. The premiums charged for new construction vary according to its exposure to flood damage. The community's flood plain management efforts become more comprehensive: new buildings are elevated or flood proofed to certain flood levels. These levels are derived from FEMA's FIS for the community. This more detailed map is a Flood Insurance Rate Map (FIRM) which shows flood elevations and outlines risk zones used for insurance purposes.

All of the communities within the Neponset River basin are enrolled in the National Flood Insurance Program. Presented below

is the status as of January 1982.

Community	Program	Effective Date	Other
Boston	Emergency	--	FIS due 4/82
Quincy	Regular	9/21/73	Being updated
Milton	Regular	4/3/78	--
Dedham	Regular	12/1/78	--
Canton	Regular	4/3/78	--
Westwood	Regular	11/2/73	Being updated
Norwood	Regular	2/1/80	--
Sharon	Regular	9/29/78	--
Walpole	Regular	10/1/77	--
Foxboro	Regular	12/15/79	--
Stoughton	Emergency	--	FIS due
Randolph	Regular	5/1/78	--
Dover	Regular	6/18/80	--
Medfield	Regular	7/16/79	--

3. Department of Agriculture

a. Pine Tree Brook - In May 1968, a "Work Plan for Watershed Protection and Flood Prevention for the Pine Tree Brook Watershed" was composed by the U.S. Department of Agriculture (USDA), Soil Conservation Service (SCS) and Forest Service, and sponsored by the Norfolk Conservation District and the town of Milton in cooperation with the Massachusetts Department of Natural Resources, Divisions of Fisheries and Game and Forests and Parks, and the Water Resources Commission. Prepared under the 1954 authority. of the Watershed Protection and Flood Prevention Act, Public Law 83-566, as amended, Pine Tree Brook Reservoir was completed in 1970.

This multipurpose structure not only retards floodwaters, but also creates a habitat for native wildlife. This structure, controlling about 53 percent of the drainage area, provides almost complete protection from flood damage caused by an event with a frequency in excess of 100 years. Supplemental work plans agreed upon in January 1970 and March 1971 lowered the impoundment level by a foot and added forestry land treatment measures, respectively.

Prior to this study the town of Milton, realizing its vulnerability to flooding along Pine Tree Brook, completed an extensive program of channel improvements throughout the major portion of the damage areas. Construction was begun in 1954 and

cost approximately $700,000.

b. Westwood - "Flood Hazard Analyses for Major Streams Within the Town of Westwood" was prepared in May 1974 by SCS in cooperation with the Massachusetts Water Resources Commission and the Norfolk Conservation District. The investigation was authorized under Section 6 of PL 83-566 for a flood insurance study. It was intended to enable the town to prepare zoning regulations and ordinances to regulate development and use of flood plains, thereby reducing potential flood damages. This study is significant in that possible nonstructural flood plain management alternatives were identified. Examples of wise flood plain usage were also included.

c. Traphole Brook - Authority under PL 83-566 allowed for study by SCS of the Diamond-Traphole Brooks watershed located in Walpole. Flooding along the lower reaches of the two streams is a major concern. Increased runoff due to development has magnified the problem. Recurrence of a flood equivalent to Hurricane Diane in August 1955 would cause damages of about $700,000 along Diamond Brook and $200,000 (1972 price levels) along Traphole Brook. This Watershed Work Plan was completed in December 1972.

The plan found that structural flood control measures could not be economically justified for Traphole Brook. The results of this study showed a need for flood plain management to supplement the effects of land treatment in alleviating future flood problems. Recommended measures included flood proofing, flood insurance, modification of existing culverts and acquisition of flood plain areas.

d. Diamond Brook - However, further study on Diamond Brook resulted in a 1975 Watershed Work Plan recommending conservation land treatment; a multiple-purpose structure with storage for floodwater, fish and wildlife; and about 1,180 feet of channel work for flood prevention. The channel work involves the installation of about 780 feet of reinforced concrete conduit to supplement an existing conduit and enlargement of about 400 feet of stream channel.

The multiple-purpose structure and channel work will supplement the land treatment measures to effectively solve the principal floodwater problem on Diamond Brook. Protection will be provided to the major damage areas from a storm equal to that of August 1955. The proposed project will provide an estimated 99 percent reduction in average annual floodwater damages on Diamond Brook. The multiple-purpose structure will provide a 17-acre pool which will support a warm water fishery and wetland wildlife. The

opportunity for fishing and other forms of passive recreation will be provided by the pool and 20 acres of adjacent public land.

In January 1982 SCS reported that the multiple-purpose flood prevention and fish and wildlife dam structure was completed in June 1981. Construction of the conduit section is planned for the latter part of 1982.

C. COMMONWEALTH OF MASSACHUSETTS

The Commonwealth of Massachusetts has made several studies of the Neponset River since 1873. One, a report entitled "Sanitary Conditions and Improvement of the Neponset Meadows," was prepared in 1897 by the State Board of Health. Other studies have been made by the Massachusetts Drainage Commission, the Metropolitan District Commission, the Department of Public Health, the Metropolitan District Water Supply Commission and the Department of Natural Resources. Early studies, primarily in the interest of water quality and flood protection, included Massachusetts House Documents: No. 1780, dated 1916; No. 241, dated 1938; No. 1925, dated May 1945; No. 1440, dated December 1945.

1. State Department of Health - Some dredging and straightening of the Neponset through the marshes was accomplished by the State in 1911, 1915 and 1919. The dredging, deepening and improvement was provided for by Chapter 655 of the Acts of 1911. The work was accomplished in three phases: dredging from Mattapan Mills to Mother Brook, from Mother Brook to Paul's Bridge and from Paul's Bridge to above Traphole Brook. The total dredging amounted to 440,000 cubic yards of earth and 1,105 yards of rock.

The report by the State Department of Health under the authority of Chapter 93 of the Resolves of 1915 reviewed the work that was done and recommended further work, most important of which was the removal of the flashboards on the Mattapan Mills dam. The channels finally excavated were modified to give bottom widths of 50 feet from Mattapan Mills to Mother Brook, thence 34 feet to Paul's Bridge, 18 to 18.3 feet from Paul's Bridge to Ponkapog Brook, 19 to 22 feet from Ponkapog Brook to the Canton River, and about 18 feet from the Canton River to a point above Traphole Brook. The depth below the river banks from Mattapan Mills to Mother Brook was about 8.5 feet, from Mother Brook to Paul's Bridge about 7.5 feet, from Paul's Bridge upstream the depth below the elevation of the Neponset Meadows varied from 10.5 feet at the lower end to 7.6 feet at the upper end.

Channel clearing work, consisting of the removal of brush and

debris, was performed by the State following the hurricane and flood of 1938. Sedimentation and erosion have subsequently nullified, to a great extent, the effects of these improvements.

2. Metropolitan District Commission - A preliminary report of the Neponset River was authorized by the General Court under Chapter 82 of the Resolves of 1954, and printed as Massachusetts House Document No. 2469 in January 1955. This report was followed up with a report authorized under Chapter 56 of the Resolves of 1955 and printed as Massachusetts House Document 3014, June 30, 1955.

The report stated that a project to improve the drainage situation in the Neponset River appeared to be a feasible undertaking, and the estimated cost of the project would be approximately $1.75 million. In general, the work to be done would consist of deepening and widening the present river channel and straightening of alignment at numerous other locations. This work could cover a distance of approximately 10 miles from above the Mattapan Mills dam to the upper end of the Fowl Meadow , in the vicinity of Traphole Brook in the town of Norwood. Also included was the lowering of the water level at the Mattapan Mills dam by 3 feet. In addition to the widening and deepening of the river channel, the proposed work also included provisions for the grading and restrictions against filling or construction of a strip of land averaging approximately 200 feet in width along the banks of the river through the meadows.

The report also investigated the potential flood danger in that portion of the Neponset River below the Mattapan Mills dam, and in particular of the possible effect of the proposed work above the dam. It was concluded that practical and feasible measures of control at the various dams in this lower portion of the river, together with enlargement or deepening of the channel at certain critical points, would offset the increase in flood peaks which could be expected to result from the proposed work above the Mattapan Mills. With the loss of storage in the Fowl Meadow, peak flows were estimated to be 20 percent higher. Substantial areas of land on both sides of the Neponset River between Paul's Bridge and Traphole Brook are subjected to almost yearly flooding, and as a result this land is almost wholly marshland and swamp.

Chapter 743 of the Acts of 1955 authorized the Metropolitan District Commission (MDC) to improve the Neponset River and its tributaries, and appropriated $2 million for this purpose.

3. The Department of Natural Resources published a special report entitled "The Advisability of Preserving the Wetlands, So

Called, of the Neponset River Valley for Certain Purposes," under Chapter 21 of the Resolves of 1963, House Report No. 3567, dated January 1964. This document recommended that the Department of Natural Resources (DNR), in conjunction with local communities and Norwood Airport, explore "the possibilities of a cooperative venture in the acquisition of open space under Title VII of the Housing Act of 1961 in the Fowl Meadow from Route 128 to Sharon . . ." Specific reasons cited included the preservation of a natural environment near urban and suburban development for relief from extensive urbanization; protection of an area of recreation in a variety of forms; water supply, water storage, and streamflow conservation; and minimization of flood damage.

In addition, the report recommended that a more detailed study be accomplished in the interest of flood prevention under the Watershed Protection and Flood Prevention Act, Public Law 566, 83rd Congress, as amended; establishment of Flood Plain or Conservancy Districts; acquisition of natural areas isolated by Interstate 95; and "the filling of wetlands for . . . development . . . be reduced to a minimum."

4. The MDC and the DNR published a report in December 1969 entitled "Department of Natural Resources Carrying Out Certain Water Management Projects on the Neponset River and Acquiring Certain Lands Adjacent to the River for Conservation and Recreation Purposes," under Chapter 44 of the Resolves of 1969, House Report No. 4940. This study was significant in that it was the first to fully realize the value of the wetlands in the Neponset River basin as natural valley storage areas. "Extensive downstream damage was avoided in 1968 because of the tremendous natural storage of the Neponset flood plains." The report also disputed the findings of the 1955 House Report, No. 3014. Hurricane Diane in August 1955 shed new light on the flood situation throughout the region.

House Report No. 4940 recommended a watershed management plan founded on analysis of "the relative effects of loss of storage due to various degrees of encroachment . . ." As part of this management plan, it was recommended that the communities within the watershed draft strict flood plain zoning. Finally, a low flow augmentation study and public acquisition of recreational lands in the interest of flood protection and other related purposes were advised.

5. The Massachusetts Water Resources Commission retained an engineering consultant to undertake a study to develop a hydrologic and hydraulic methodology suitable to relate various degrees of future urban encroachment of the natural floodwater

storage capacities of the flood plains and wetlands throughout the Neponset River basin, with the corresponding increases in flood elevations and discharges.

The results of the study, completed in 1971, indicated that flood stages were increased due to flood plain and wetland encroachment. For comparative purposes, the basinwide flood stage increases for the 100-year flood ranged from 0.5 feet with a 10-percent loss of flood storage to 3.0 feet with a 50-percent loss of storage. Considering the vast volume of flood storage and acreage of flood plain within the basin, these seemingly small increases in flood stage affect a very large area, and were therefore considered very significant.

Historical water surface profiles were developed for the main stem Neponset River, between the Metropolitan District Commission dam at the Diamond International Company to the U.S. Geological Survey gaging station at Norwood. Profiles for events having recurrence intervals of 5, 25, 100 and 500 years were developed for present land use conditions, future land use conditions without encroachment and future land use conditions with varying degrees of flood plain and wetland encroachment. A very important assumption associated with the study was that the MDC dam at Diamond International Co. was considered to be fully open during major flood flows. Flood profiles and increased flood stages reflected this assumption. These profiles provided the means for preliminary determination of the effect of encroachment on flood elevations along the main stem of the Neponset River.

D. REGIONAL

1. The Neponset Conservation Association - Considerable interest has been demonstrated by other concerned parties in the problems of the Neponset River valley. The Neponset Conservation Association (NCA) has been an instrument for use as a forum by the Conservation Commissions of the communities in the watershed. The Association also includes major industries, the Neponset Reservoir Company and other environmental groups. The NCA has generated strong support for resource management and has demonstrated a continuing concern that the proper solution be applied to the problems of the Neponset flood plains.

The citizens and public officers of the individual communities in the Neponset watershed have worked hard to protect wetlands and water resources, particularly in the adjoining uplands and along the streams tributary to the Neponset. Tracts of land have been acquired by local conservation commissions in every community and several of these acquisitions have been assisted with funds from the Self-Help Program administered by the Department of Natural Resources.

In addition, the NCA has sponsored certain wetland areas within the watershed for designation as Areas of Critical Environmental Concern (ACEC). Its report is included as Appendix E.

2. The League of Women Voters - "A Neponset River Basin Study" by the Water Resources Committee of the League of Women Voters details the background and history of the Neponset, and lists the multiplicity of interests and agencies involved with the river. This study highlights the fact that the complexity of differing demands, the lack of essential hydrological information to settle the conflicting arguments, and the uncertainty over the ability to correct the pollution situation has inhibited the development of a clear-cut plan.

3. The Metropolitan Area Planning Council

a. Recreation - "The Mystic, Charles and Neponset Rivers," Volume 3, Open Space and Recreation Program for Metropolitan Boston, April 1969, by the Metropolitan Area Planning Council (MAPC) outlines the existing condition and potential resources of the three rivers that enter metropolitan Boston.

The MAPC report contains several recommendations concerning the Neponset River. These propose numerous trails, parks, recreational opportunities and the acquisition of remaining open meadow land for public use and benefit. Each section of the river is considered separately, and is mapped to illustrate in detail how each reach of the stream can best contribute to the overall plan. These excellent recommendations attract broad based support.

b. Water Quality - Section 208 of the Water Pollution Control Act Amendments of 1972 (PL 92-500) established areawide water quality planning programs across the Nation. In 1975 MAPC, greater Boston's officially designated regional planning agency, was selected to oversee such a program for the member communities within its jurisdiction, including those within the Neponset River Basin.

MAPC submitted its 208 Water Quality Project for the Neponset watershed in December 1977 citing the importance of wetlands legislation, checking development, preventing water quality degradation and reducing flood damage. This study, like EMMA, provides valuable data that can reduce duplication of effort. This flood plain management study is meant to complement 208 water quality planning.

APPENDIX B

GEOTECHNICAL FEATURES

APPENDIX B

GEOTECHNICAL FEATURES NEPONSET RIVER BASIN

A. BASIN TOPOGRAPHY

The Neponset River basin southwest of Boston, Massachusetts, is in the Seaboard Lowland section of the New England physiographic province. The relief of the basin is low to moderate with generally a rolling surface expression. Altitudes range from sea level at the coast to a maximum of over 600 feet at Great Blue Hill on the eastern margin. Most of the basin is below 300 feet. The varied relief is caused by an irregularly eroded bedrock surface covered by a variety of glacial deposits. Exposures of rock are scattered throughout. There is evidence of a narrow buried valley generally below the Neponset River which may be more than 100 feet below sea level in places.

The Neponset River flows northeasterly and is fed by a number of tributary streams. There are a few sizeable lakes. A few extensive swamps are in the broad poorly drained areas. The watershed comprises 115 square miles.

B. SURFICIAL GEOLOGY

The region has been glaciated. The advance and retreat of glaciers resulted in some erosion of the bedrock surface and deposition of rock materials in various land forms. The unconsolidated surficial materials covering the rock are primarily glacial deposits. There are some recent deposits and man-made fills. The glacial deposits classified by their nature of deposition are till, kame terraces, kame plains, kames, outwash plains and undifferentiated sands and gravels. Recent deposits are swamp and marsh materials and artificial fills. The materials are described below.

Till. Till is an unsorted mixture of rock particles of local origin varying from clay to boulders in size. It occurs as an irregular layer which may be thin to over 100 feet thick locally. Till has widespread occurrence in the basin and may underlie other surficial deposits. Commonly, till is compact and has low permeability because of the clay content. High runoff and poor drainage qualities are significant characteristics. Although there are large amounts of water stored in the thicker deposits, till is a poor aquifer because it transmits water very slowly.

Kame. Kames are water-laid conical hills or short irregular ridges of sand, gravel and boulders which were deposited in contact with the glacier. The material is stratified and pervious. Kames usually are localized deposits and therefore have limited influence on groundwater. Kame fields are broad areas where there are numerous kames clustered.

Kame plains. Kame plains in this area are flat topped delta deposits which had their bounding slopes deposited in contact with glacial ice. The material is stratified sand and gravel which may vary from several tens of feet thick to more than 100 feet locally. The material is pervious. Local groundwater table conditions govern the occurrence and abundance of water.

Kame terraces. Kame terraces are small local deposits of sand and gravel laid down by stream between glacial ice masses and valley walls. The materials are variably sorted and stratified and are pervious.

Outwash plains. Outwash plains occupy broad low areas and consist of well stratified sand and gravel several tens of feet thick. Such deposits usually are good aquifers.

Sand and gravel undifferentiated. Sands and gravels of glacial origin but occurring as unclassified land forms are scattered throughout the basin. These pervious deposits generally are small in size and with restricted distribution.

Swamp deposits. Generally, swamps occur in depressions where there is water at or near the ground surface and drainage is blocked. Swamp deposits consist of organic and fine grained inorganic materials. Generally, the small swamps in the area contain a few feet of sediment. The large swamps may have thick deposits. Borings throughout one of the larger swamps showed 1 to 28 feet of peat overlying sand. Marsh deposits occur in the low area along the coast and are similar to swamp materials.

Artificial fills. Artificial fills are placed along highways, railroads, airports and in cities and towns. Fills are commonly placed over swamp and marsh deposits.

C. BEDROCK GEOLOGY

The bedrock consists of igneous, sedimentary, and metamorphic types. Through geologic time the rocks have been structurally deformed. Therefore, their arrangement is complex and a number of faults traverse the basin. The configuration of the eroded rock surface is an important control of drainage. The various rocks have different mechanical and chemical properties and are weathered and jointed to different degrees. The interconnected openings in the rocks usually contain groundwater.

The igneous rocks are granite, syenite, granodiorite, gabbro and volcanics (including felsite, pyroclastic rock, rhyolite). Because of their crystallinity they have low primary porosity. The occurrence of water is governed by local porous zones due to weathering and jointing. They cover most of the basin and occupy broad areas.

The sedimentary rocks are relatively coarse grained and consist of sandstones and conglomerate. These types are stratified and may have intergranular voids in addition to joints. Therefore, these rocks may be important reservoirs for ground water. They are found in a band across the central area of the basin and in the northern corner.

Metamorphic rocks consisting of fine-grained argillites are the least common type and are restricted to the northeastern part of the basin. The frequency of joints would determine the local hydrologic characteristics.

D. FAULTS

Faults are fractures along which rocks have moved. The faults are old and the movement stopped prior to regional erosion. This condition would produce little or no topographic expression except where the rock types had significant differences in hardness and displacement was sufficient. The rock surface in the basin is mostly covered by overburden so that most of the actual faults are not exposed. Faults are located by interrupted continuity of rocks found by mapping, topography, and by discovered broken and crushed zones. Such zones may become healted to various degrees by mineralization. Commonly, however, the broken rock is not wholly cemented and the fault zone is a conduit for water.

E. BURIED VALLEYS

Evidence from borings and outcrops indicates that there is a buried valley beneath part of the Neponset River. The buried valley is filled such that it shows no surface expression. It has been intercepted at various spots which indicate that its axis extends for some distance back from the mouth of the Neponset River and generally follows its course. Tributary valleys apparently exist beneath Reservoir Pond, Ponkapog Brook, Purgatory Brook and Wigwam Pond. The valley is narrow and is in places more than 100 feet below sea level. Several borings show that the filling materials include some till overlain by various deposits of sands and gravels. Fill, muck and peat are the surface deposits.

F. SEISMICITY

The basin is in Zone 3 of the seismic zone map which corresponds to potential major damage due to earthquakes. Zone 3 is equivalent to intensity VIII of the Modified Mercalli scale.

G. MINERAL RESOURCES

Mineral resources within the basin are sand and gravel, peat loam, diatomite and rock. These materials have been variably exploited.

Sand and Gravel. Sands and gravels are widely distributed as glacial deposits and are the most important mineral resource of the basin. Recent spreading urbanization has precluded the exploitation of many deposits.

Loam. Wind deposited silt from a few inches to a few feet thick has been utilized in many parts of the basin.

Peat. Occurrences of peat have been found in areas of the swamp in the Neponset River Valley. Borings showed 1 to 28 feet of peat but generally it is less than 5 feet thick. The nature of deposits in other areas is not known. About in 1930, some peat was sold for fuel.

Diatomite. Some diatomite recovered from the Neponset River swamp was sold in the last 1930's and early 1940's. It was processed for use in silver polish.

Building stone. Several quarries in igneous rocks once were furnishing building stone on a small scale. Some potential sources are the Dedham Granodiorite, Westwood Granite, Sharon Syenite, and Blue Hills Granite Porphyry.

Crushed Stone. The Mattapan Volcanic Complex and Westwood Granite have been quarried for crushed stone but not on an important economic scale.

APPENDIX C

HYDROLOGY AND HYDRAULICS

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NEPONSET RIVER BASIN
HYDROLOGY AND HYDRAULICS

1. PURPOSE

This appendix presents an analysis of the flood hydrology for the Neponset River Basin southwest of Boston, Massachusetts. Included in the study was the development of "HEC-1" and "Fred" computer models using information from previous studies, recorded streamflow data, plus supplemental information determined as part of this study. The purpose was to analyze the systematic, and component, development of floods in the basin in order to assess the effects of natural valley storage areas on such flood development.

2. WATERSHED DESCRIPTION

The Neponset River has a total watershed area of about 115 square miles. It originates at the outlet of Neponset Reservoir in Foxborough and flows in a generally northeasterly direction discharging to Dorchester Bay, a part of Boston Harbor. The river has a total fall of about 270 feet in a distance of 28 miles.

Like most streams in New England that drain in a northerly direction, the Neponset is, hydrologically, a very sluggish watershed with very flat stream gradients and numerous extensive swamps and flood plains. Stream gradients in the upper watershed are steeper than those in the lower reaches. The most notable flat gradient reach of the river lies near the middle of the watershed, extending from the Walpole-Norwood town line downstream a distance of about 9 miles to the Tileston and Hollingsworth (T&H) Dam in Boston. This huge wetland flood plain, known locally as the "Fowl Meadow," covers about 3,500 acres (including Purgatory Bk.) and is by far the most significant flood plain area in the basin.

A principle tributary to the Neponset River is the East Branch or Canton River, which enters the Neponset in Canton near the upper end of the Fowl Meadow storage reach. Another is Mother Brook which discharges into the river about 1.3 miles downstream of the Fowl Meadow. A unique feature of Mother Brook is that it diverts up to 1/3 of the flow of the neighboring Charles River to the Neponset River. This diversion, which was originally made for industrial use on the Neponset River, continues today. Since the drainage area of the Charles at the point of diversion is 198 square miles, the Mother Brook diversion in effect adds the equivalent of 66 additional square miles of drainage to the lower Neponset.

A summary of watershed areas in the Neponet basin are listed in Table C-1. A watershed map of the Neponset is shown as Plate C-1. This analysis dealt with that portion of the Neponset basin upstream of the "T&H" Dam. This dam is located about 1 mile downstream from the mouth of Mother Brook, about 6 miles upstream from the mouth of the river, and about 2 miles

upstr[illegible] from Tidewater. The T&H Dam is at the downstream end of the Fowl Meadow reach and discharges the flow from over 85 percent of the total Neponset watershed.

TABLE C-1

NEPONSET RIVER BASIN
WATERSHED AREAS

Location	Area (sq. mi.)	Total (sq. mi.)	Effective* (sq. mi.)
Neponset R. at Norwood USGS gage	35.2	-	-
East Br. at Canton USGS gage	27.2	62.4	-
Local to Paul's Bridge	30.8	93.2	-
Local to T&H Dam	4.4	97.6	163.8
Local to Mouth	17.0	114.6	181.6

* Flow diverted from Charles River adds 66 square miles to effective watershed.

3. CLIMATOLOGY

Average annual precipitation in the region is about 47 inches with a maximum of about 60 inches and a low of 25 inches. Precipitation is fairly uniformly distributed throughout the four seasons of the year but characterized by frequent short periods of heavy precipitation. The basin is exposed to "prevailing westerlies," low pressure ystems that travel across the country from west or southwest. The area is also exposed to intense coastal storms that travel up the Atlantic seaboard in the form of hurricanes of tropical origin and storms of extratropical nature, often called "northeasters." Much of the precipitation during the winter months, December through February, occurs as snow with an average annual snowfall between 40 and 50 inches. The water equivalent of the snowpack normally reaches a maximum around the 1st of March, averaging about 2.5 inches.

Mean, maximum and minimum monthly temperatures and precipitation, recorded at Blue Hills, Massachusetts are listed in Tables C-2 and C-3, respectively. The Blue Hills station is centrally located to the Neponset basin but on a hill at elevation 630 feet NGVD.

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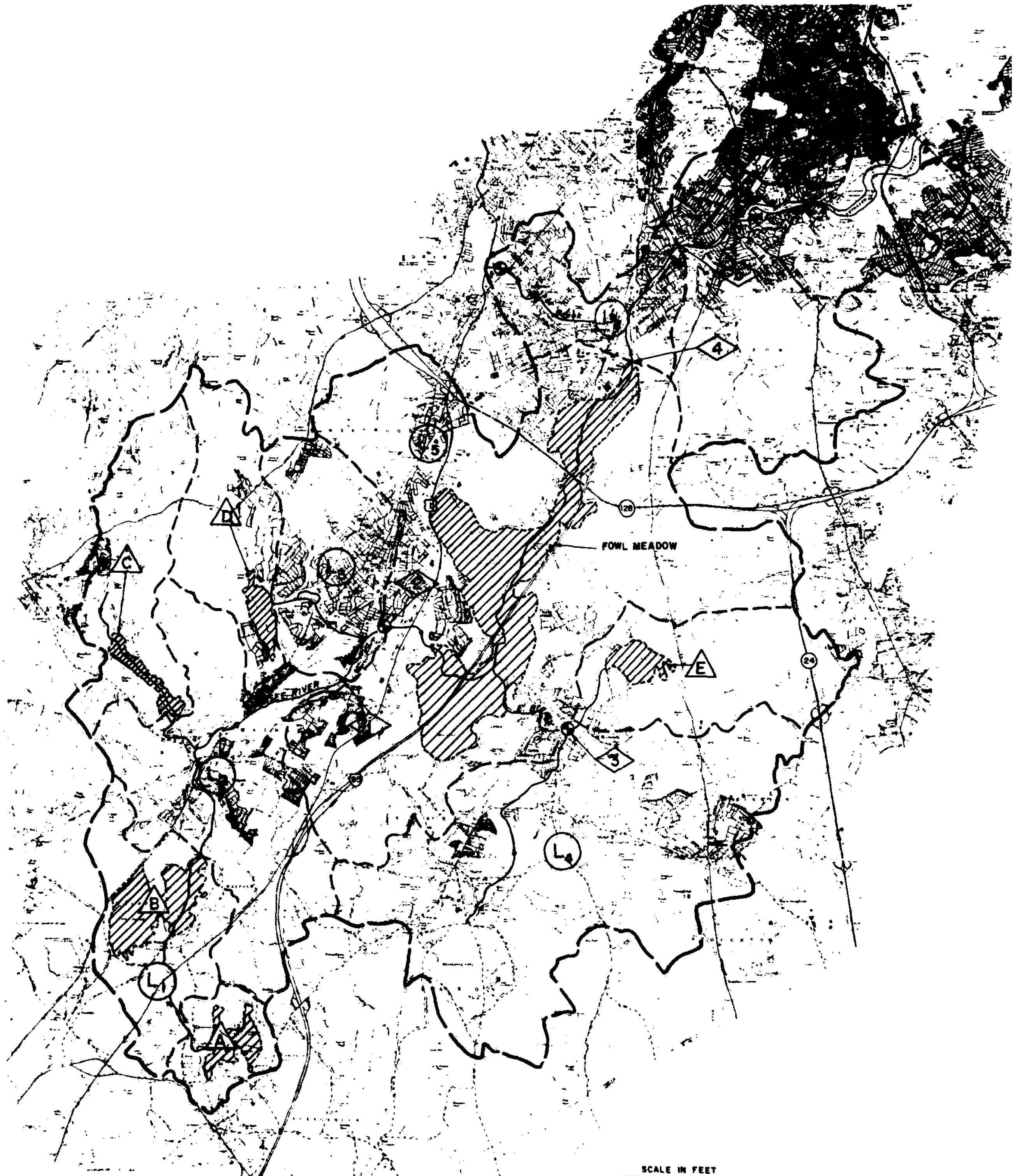

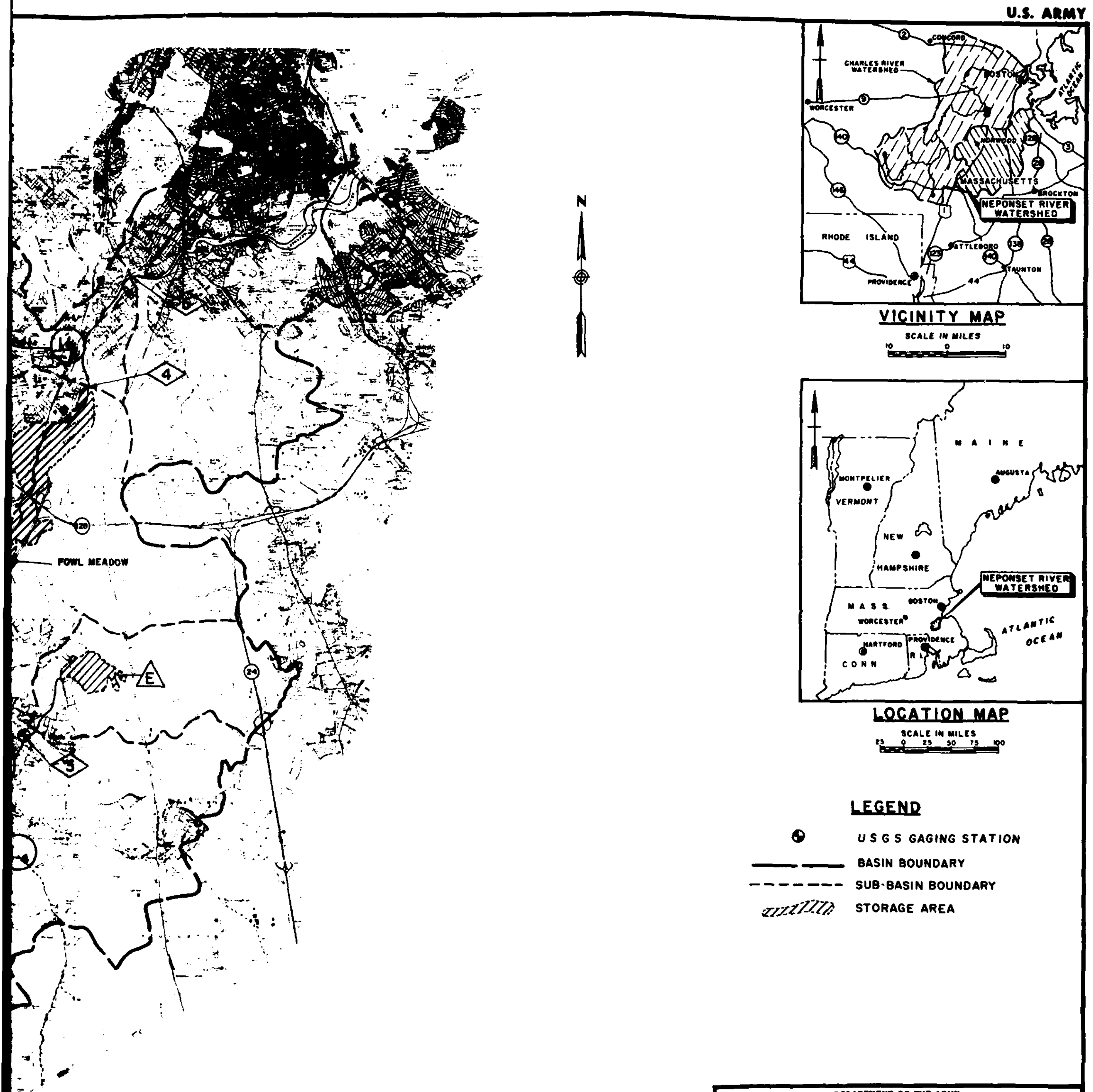

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WALTHAM, MASS.

NEPONSET RIVER BASIN

BASIN MAP

HYDRO ENG. SECT. MARCH 1981

PLATE C-1

TABLE C-2

MONTHLY TEMPERATURES
(° Fahrenheit)
BLUE HILLS, MASSACHUSETTS
(PERIOD 1885-1980)

Month	Mean	Maximum	Minimum
Jan	25.1	68	-16
Feb	25.4	67	-21
Mar	33.6	85	- 5
Apr	44.1	89	6
May	55.0	93	27
Jun	63.9	99	36
Jul	69.4	99	46
Aug	67.7	101	39
Sep	60.8	99	28
Oct	50.6	88	21
Nov	39.7	81	5
Dec	28.7	68	-19

TABLE C-3

MONTHLY PRECIPITATION
BLUE HILLS, MASSACHUSETTS
(96 Years of Record)

	Mean (inches)	Maximum (inches)	Minimum (inches)
January	4.23	11.61	.89
February	3.96	9.32	1.04
March	4.29	10.96	.06
April	3.84	8.71	.92
May	3.62	9.16	.50
June	3.42	10.78	.53
July	3.52	11.67	.13
August	4.14	18.78	1.22
September	3.98	11.04	.45
October	3.80	10.84	.22
November	4.23	9.29	.55
December	4.31	12.60	.92
Annual	47.3	63.8	27.0

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NEPONSET RIVER BASIN MASSACHUSETTS, FLOOD PLAIN MANAGMENT STUD--ETC(U)

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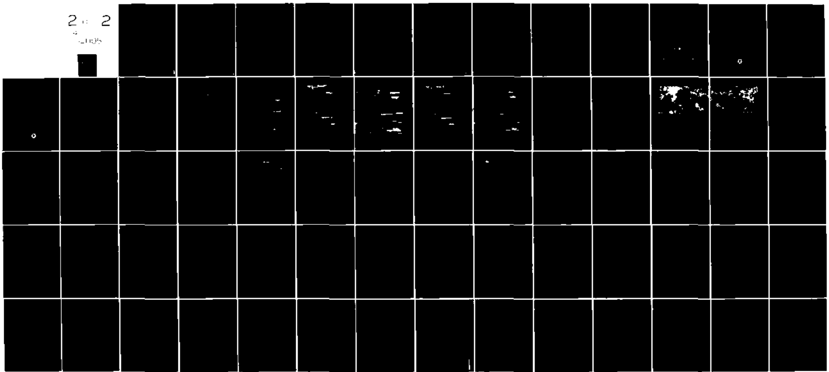

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4. STREAMFLOW DATA

The U.S. Geological Survey (USGS) has recorded Neponset River streamflow at Norwood (D.A. = 35.2 sq. mi.) continuously since 1939 and on the East Branch at Canton (D.A. = 27.2 sq. mi.) since 1952. The combined flows of these two stations approximate the inflow into the upper end of the Fowl Meadow storage reach.

There is a USGS streamflow gage on Mother Brook which, in effect, records the diversion of water from the Charles River to the Neponset River. There are no gaging stations on the lower main stream of the Neponset below the Fowl Meadow storage.

Average annual runoff in the Neponset basin is about 21 inches or about 45 percent of average annual precipitation. Mean, maximum and minimum monthly flows in cfs and inches of runoff at the two gaging stations are listed in Tables C-4 and C-5. Peak flows at the two gages occurred in August 1955 when the flows were 1,490 and 1,790 at Norwood and Canton, respectively. These peak flows represent runoff rates of 42 and 66 cfs per square mile of drainage area, respectively. These relatively low runoff rates, particularly that of the Neponset River at Norwood, reflect the hydrologically sluggish character of the watershed and the storage effect of its numerous natural valley storage areas.

TABLE C-4
MONTHLY RUNOFF

Neponset River at
Norwood, MA
(D.A. = 35.2 sq. mi.)
41 Years of Record
Through 1980

	CFS			INCHES		
Month	Mean	Max	Min	Mean	Max	Min
January	69.9	159	12.3	2.29	5.20	.40
February	74.7	188	19.1	2.20	5.56	.56
March	113	211	49.4	3.71	6.91	1.62
April	96.7	189	31.8	3.07	5.99	1.01
May	63.1	146	25.6	2.07	4.78	.84
June	34.6	116	11.4	1.10	3.70	.36
July	19.2	79.3	6.7	.63	2.60	.22
August	23.2	226	6.5	.76	7.40	.21
September	22.6	87.7	6.8	.72	2.78	.21
October	26.7	121	6.0	.87	4.13	.19
November	44.7	188	5.9	1.42	5.96	.19
December	59.2	156	7.8	1.94	5.11	.23
Annual	53.9	87.9	21.7	20.8	33.9	8.4

TABLE C-5
MONTHLY RUNOFF

E. Branch Neponset River
at Canton, MA
(D.A. = 27.2 sq. mi.)
28 Years of Record
Through 1980

	CFS			INCHES		
Month	Mean	Max	Min	Mean	Max	Min
January	74.8	177	10.6	3.17	7.50	.45
February	118	132	36.4	4.53	5.05	1.39
March	99.9	135	47.6	4.23	5.72	2.02
April	86.4	190	20.7	3.54	7.79	.85
May	56.6	142	20.2	2.32	5.82	.83
June	29.9	92.4	8.6	1.23	3.79	.35
July	17.2	55.8	4.5	.73	2.37	.19
August	23.5	203	3.6	.99	8.60	.15
September	23.2	76.2	4.4	.95	3.13	.18
October	30.6	100	6.4	1.30	4.24	.27
November	47.4	161	8.4	2.01	6.60	.34
December	64.7	129	9.8	2.74	5.47	.41
Annual	52.3	74.8	18.6	27.7	37.3	9.3

Annual peak flows at the two gage sites are listed in Table C-6 and the computed peak discharge frequency curves are shown on Plate C-4. Peak discharge frequencies were computed using a Log Pearson Type III distribution in accordance with procedures set forth in Water Resources Bulletin No. 17A.

TABLE C-6
ANNUAL PEAK FLOWS

	Neponset River at Norwood, MA (D.A. = 35.2 sq. mi.) (cfs)	E. Branch Neponset River at Canton, MA (D.A. = 27.2 sq. mi.) (cfs)
1940	226	-
1941	240	-
1942	304	-
1943	230	-
1944	200	-
1945	254	-

Year	Neponset River at Norwood, MA (D.A. = 35.2 sq. mi.) (cf)	E. Branch Neponset River at Canton, MA (D.A. = 27.2 sq. mi.) (cf)
1946	414	-
1947	212	-
1948	398	-
1949	165	-
1950	176	-
1951	255	-
1952	336	-
1953	398	374
1954	430	398
1955	1490	1790
1956	486	598
1957	247	292
1958	384	360
1959	321	293
1960	247	221
1961	318	334
1962	368	281
1963	473	642
1964	392	304
1965	304	258
1966	193	260
1967	392	490
1968	1140	1420
1969	636	645
1970	681	887
1971	298	408
1972	427	450
1973	432	371
1974	410	418
1975	303	273
1976	684	492
1977	400	367
1978	529	922
1979	837	809
1980	443	375

5. REFERENCE STUDIES

Some previous studies, by others, that addressed the hydrologic effects of flood plains in the Neponset basin are as follows:

a. "Report of a Joint Board on The Study of the Neponset River," Commonwealth of Massachusetts, House Report No. 3014, June 30, 1955. (Engineer's Report by Howard M. Turner).

b. "Report of the Department of Natural Resources Study of the Wetlands of the Neponset River Valley," Commonwealth of Massachusetts, House Report No. 3567, January 29, 1964.

c. "Report of the Metropolitan District Commission and the Department of Natural Resources Relative to the Department of Natural Resources Carrying Out Certain Water Management Projects on the Neponset River and Acquiring Certain Lands to the River for Conservation and Recreation Purposes," Commonwealth of Massachusetts, House Report No. 4940, December 1969.

d. "Neponset River Basin Flood Plain Wetland Encroachment Study," Massachusetts Water Resources Commission, Division of Water Resources, April 1971 (study by Anderson-Nichols Co., Inc.).

Turner's 1955 study , see "a" above, made reference to drainage projects in the Fowl Meadow Flood Plain, "in the interest of water quality and flood control," dating back to the 1885 to 1915 era. Turner developed an engineering plan for deepening and widening the Neponset River throughout the length of the Fowl Meadow reach. The work would extend over a distance of approximately 10 miles and the channel straightening would decrease the river length from 9.3 to 7.8 miles through the Fowl Meadow. The channel would be excavated to a width varying from 100 feet to 60 feet, and a 100-foot wide floodway strip would be preserved on both sides of the river channel. Excavated materials would be deposited as fill material outside the limits of the floodway. Mattapan Mills dam (T&H Dam), at the lower end of the Fowl Meadow would be equipped with a bascule gate to permit normal water level regulation. With this drainage plan, it was envisioned that industrial development would be possible throughout the Fowl Meadow, outside the floodway.

However, it was recognized by Turner that water depths in the Meadows outside the floodway would be about 3 feet deep during a major flood. A major flood was estimated at that time to be about a 100-year frequency event, and, with loss of Fowl Meadow storage, would have a peak outflow above Mother Brook of 3,000 cfs and below Mother Brook of about 4,600 cfs. Based on an analysis of the March 1936 flood, Turner estimated that the loss of the Fowl Meadow storage would increase downstream peak flows in the order of 20 percent. It is noted that Turner's report was completed just months before the great flood of August 1955.

The January 1964 House Report No. 3567 (referred to as the Gullion Report) took exception to the then authorized "Turner" drainage plan. It stressed that such a drainage plan, in combination with the construction of highway Routes 128 and I-95 and the industrial development this would entice, would have a devastating effect on the environmental value of the

natural Fowl Meadow flood plains. The report further suggested that the earlier study underestimated the potential effect the drainage project would have on peak flood flows, particularly when considering the added effect of replacing peat with pavement the-result of industrial development. In conclusion, this report strongly recommended action to preserve valuable wetlands and flood plains as open space in the Neponset watershed.

The December 1969 joint report by the Metropolitan District Commission and Department of Natural Resources (House Report No. 4940) addressed and reviewed many water related problems in the basin including flooding. The principle conclusion was that intelligent watershed management and coordinated land use planning was needed on a regional basis to curtail increased flood damages. It further concluded that hydrologic and hydraulic evaluation was needed to determine the relative effect of flood plain encroachment on flood stages and heights. At the time of the 1969 report, the 1955 authorized drainage plan had only been completed in the lower reach extending about 2 miles upstream from the T&H dam, including the installation of a bascule gate at the T&H dam.

The 1971 report prepared by Anderson-Nichols & Co., Inc. attempted to develop a general purpose method for estimating the relative effect of flood plain encroachment and worked with the Neponset only as a pilot basin. Data and information on the Neponset, developed and furnished by Anderson-Nichols, was used extensively in this study.

6. STUDY PROCEDURE

The hydrologic analysis of the basin consisted of analyzing the component watersheds of the East Branch and Neponset Rivers upstream of their respective gaging stations. The contributions of these two watersheds were then combined with downstream local inflows plus the Mother Brook contribution for an analysis of the principal Fowl Meadow natural storage reach. Analysis of the two watersheds and the local areas was facilitated by the use of the computer program HEC-1, "Hydrograph Package." The more complex analysis of the Fowl Meadow storage was made by the somewhat novel, but quite appropriate, application of the flood routing capabilities of the National Weather Service program developed by Dr. Fred, entitled: "Dam Break Flood Forecasting Model." The upstream HEC-1 models were calibrated against recorded rainfall and runoff events and the Fred model was calibrated using recorded high water data through the Fowl Meadow reach. Once calibrated the models could be used and/or modified for use in assessing the hydrologic effects of flood plain storage in the Neponset basin.

7. HEC-1 MODELS

a. Neponset River - The Neponset River watershed was divided into the subwatersheds of four natural storage areas, "A" through "D," plus those of three local areas, L_1 through L_3. The three locals were actually further subdivided for purposes of the model, however, this is not pertinent to an

understanding of the overall analysis. The subwatersheds "A" through "D" and L_1 through L_3 are identified on the watershed map shown on Plate C-1. A study schematic is shown as Plate C-2. Storage area "A" was the Neponset Reservoir, "B" was Cedar Swamp, "C" was Mill and Mine Brooks and "D" was Willet Pond.

Stage-discharge curves were developed for each of the storage areas using field measurements of either the outlet structures or nearby culverts, and detailed photogrammetric mapping with a 2-foot contour interval. U.S. Geological Survey stage-discharge ratings were used at the two index gaging stations and extrapolated as required. Developed stage-discharge ratings were also compared with available Flood Insurance study information as applicable. Stage-storage relations were developed for each storage by planimetering topographic maps. The preceding relationships were then combined to develop discharge-storage relations for use in performing 'modified Puls' storage routings via the HEC-1 model. The adopted stage-discharge curves and surface areas of each of the storages are shown on Plate C-3.

With the required physical characteristics of the upper Neponset watershed established, the HEC-1 model was developed as follows:

(1) The recorded rainfall and resulting runoff distribution was determined for two experienced flood events; March 1968 and August 1955.

(2) Analyzing the entire watershed response, as recorded at the Norwood gage, Snyder unit hydrograph parameters; Basin Lag (Tp) and Watershed Coefficient (Cp) were estimated. These parameters were then transposed to the individual subareas for use in the HEC-1 model.

(3) Final adjustment in the selected "Tp" and "Cp" values were made based on the calibration of the model through its ability to reproduce the two experienced rainfall-runoff events and are summarized in Table C-7.

The March 1968 flood is graphically illustrated on Plate C-5. It is noted that the hydrologically sluggish character of the Neponset watershed is reflected in the relatively large "Tp" values and relatively low "Cp" coefficients.

b. East Branch Neponset - The HEC-1 model for the East Branch's watershed, upstream of the Canton gage, was developed in the same manner as that for the Neponset. These areas are identified on Plate C-1, and the discharge rating curve is shown on Plate C-3. The unit graph parameters are listed in Table C-7 and the 1968 flood is graphically illustrated on Plate C-5.

TABLE C-7
UNIT HYDROGRAPH PARAMETERS

NEPONSET RIVER

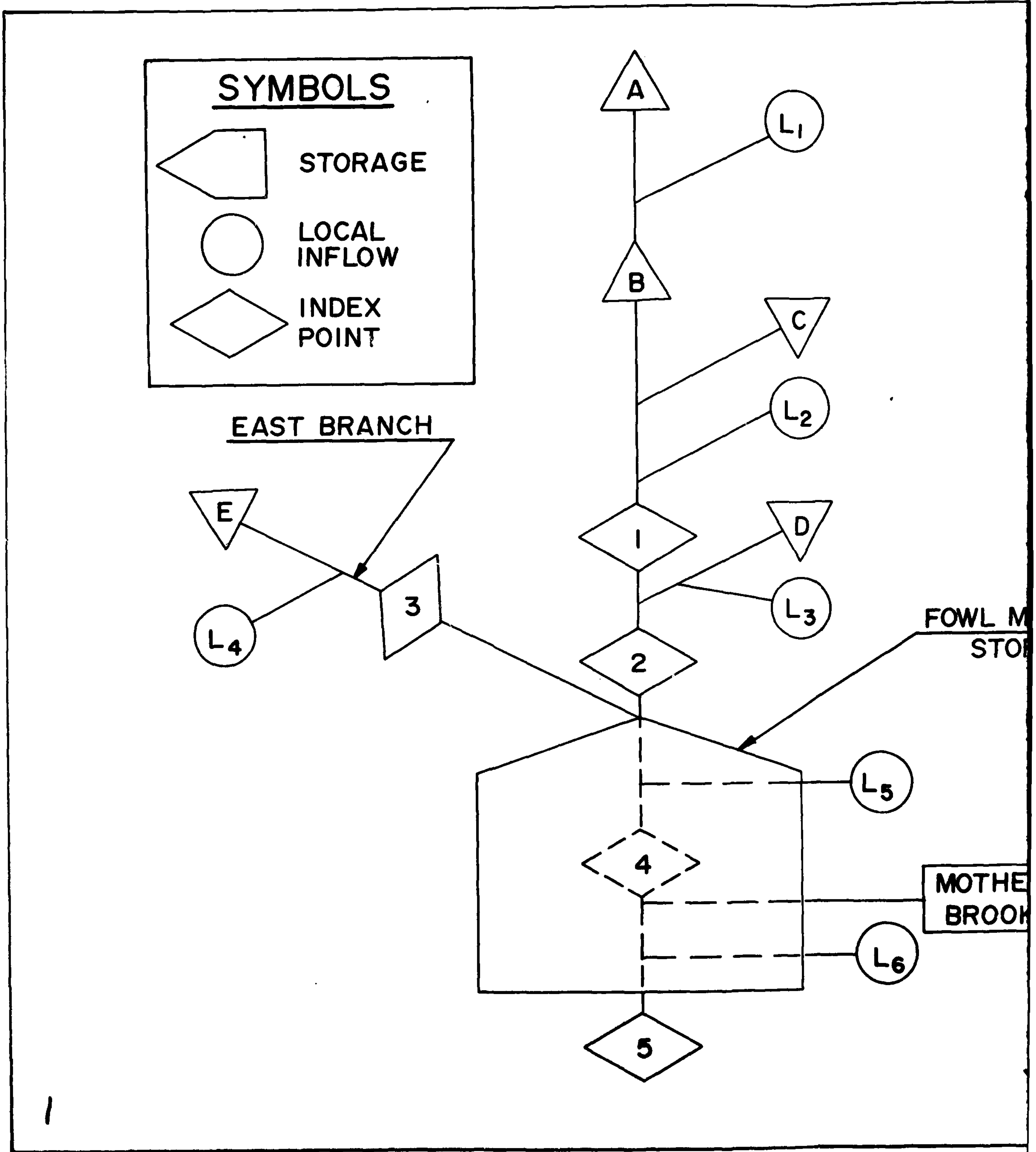
Subbasin	Area	Snyders Coefficients	
		"Tp"	"Cp"
	(sq. mi.)		(hrs)
A	2.1	9	.30
L_1	5.8	12	.30
C	6.2	15	.30
L_2	11.3	9	.30
D	4.8	9	.30
L_3	5.1	9	.30
EAST BRANCH			
E	6.8	13	.30
L_4	20.4	9	.30

c. Fowl Meadow Locals - The USGS streamflow gages on the Neponset at Norwood and East Branch at Canton measure the runoff from a combined drainage area of 62 square miles or about 60 percent of the total watershed contributing to the Fowl Meadow storage, excluding the diversion to the reach via Mother Brook. The ungaged locals to the Fowl Meadow, (L_5 and L_6) are made up of several small tributary areas draining into the Meadow. The characteristics of these tributary areas are similar to those in the Upper Neponset watershed; therefore, the unit hydrograph parameters and resulting runoff hydrographs for these local areas were patterned after those adopted for the upstream gaged watersheds.

Mother Brook diversions to the Neponset are recorded at a USGS gaging station located near the point of diversion from the Charles River to Mother Brook in Dedham, Massachusetts.

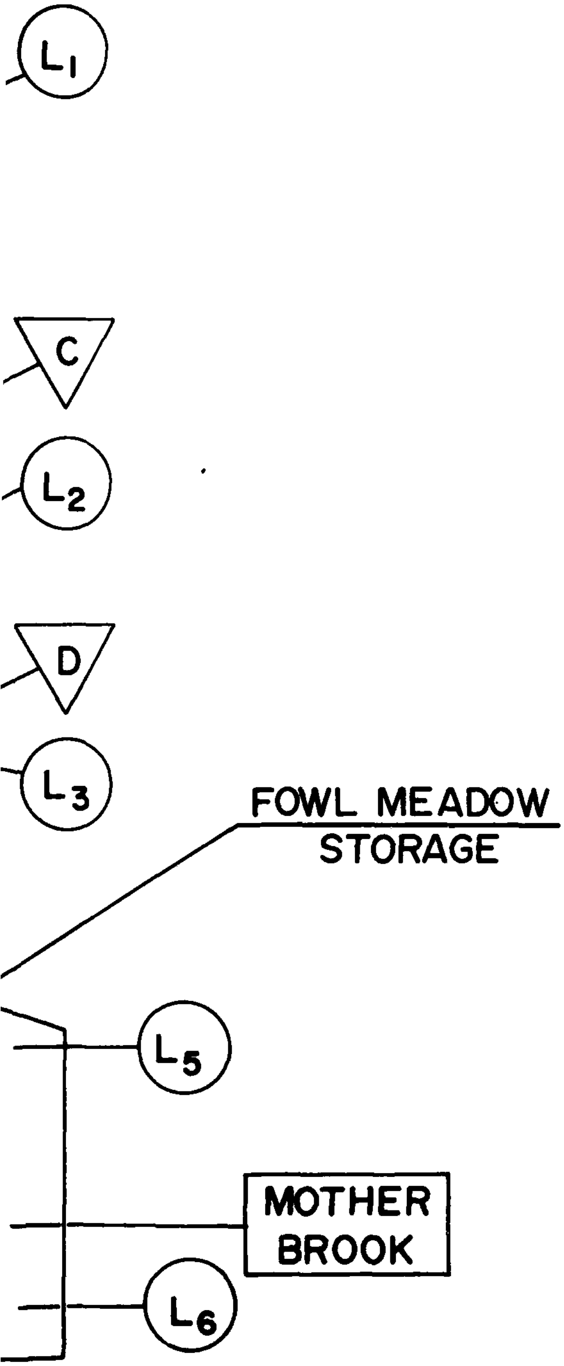
8. FRED MODEL

The Fowl Meadow is about 9 miles in length with a surface area of about 3,100 acres. During normal flow periods, the water level throughout the reach is controlled by the Metropolitan District Commission's "T&H" Dam. However, during flood periods the levels are more a function of the Fowl Meadow's hydraulic conveyance characteristics in combination with its flood modifying hydrologic storage characteristics. Based on historic high water data the difference in flood elevations from one end of the storage reach to the other is in the order of 8 to 10 feet. However, this 8 to 10 feet is probably not indicative of the gradient because it is doubtful that the highwater occurs at both ends of the reach at the same time. The levels at the upstream end probably peak and start to recede before the peak occurs in the lower end, as the flood progresses through the Meadow.



SYMBOLS
STORAGE
LOCAL INFLOW
INDEX POINT
A
B
C
D
E
L_1
L_2
L_3
L_4
L_5
L_6
1
2
3
4
5
EAST BRANCH
FOWL M
STO
MOTHE
BROOK

1



DRAINAGE AREA IN SQ. MILES

	INCREMENTAL	TOTAL
A	2.1	
L_1	5.8	
B		7.9
C	6.2	
L_2	11.3	
1 BIRD POND		25.4
D	4.8	
L_3	5.0	
2 NORWOOD GAGE		35.2
E	6.8	
L_4	20.4	
3 CANTON GAGE		27.2
L_5	30.8	
4 PAUL'S BRIDGE		93.2
MOTHER BROOK		
L_6	4.4	
5 T&H DAM-HYDE PARK		97.6

2

NEPONSET RIVER BASIN

SYSTEM SCHEMATIC

HYDRO. ENG. SECT. MARCH 1981

PLATE C-2

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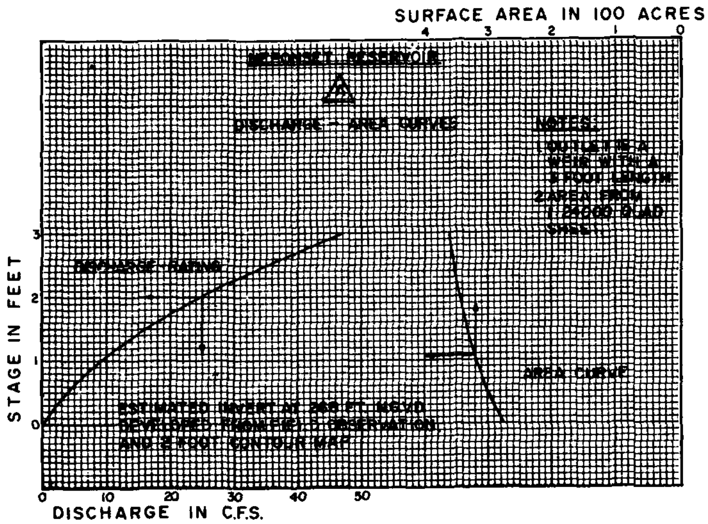

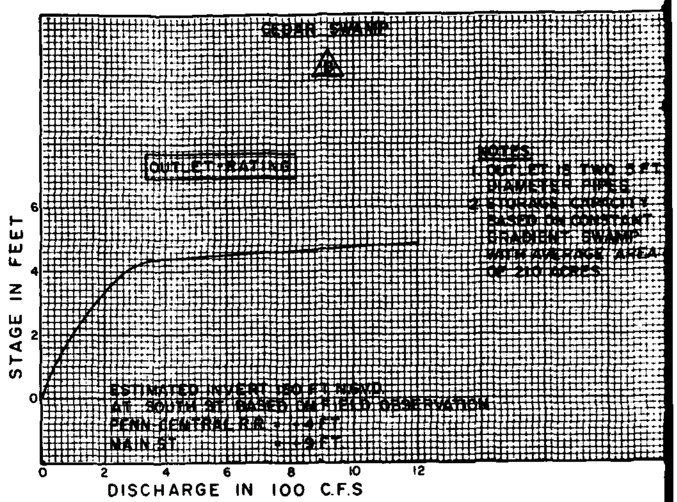

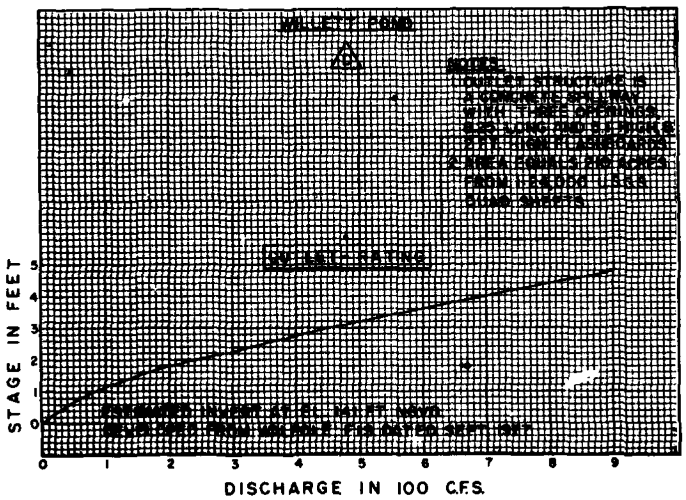

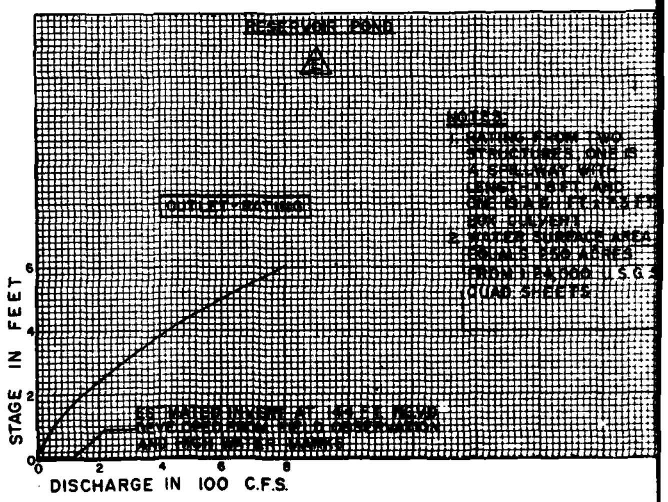

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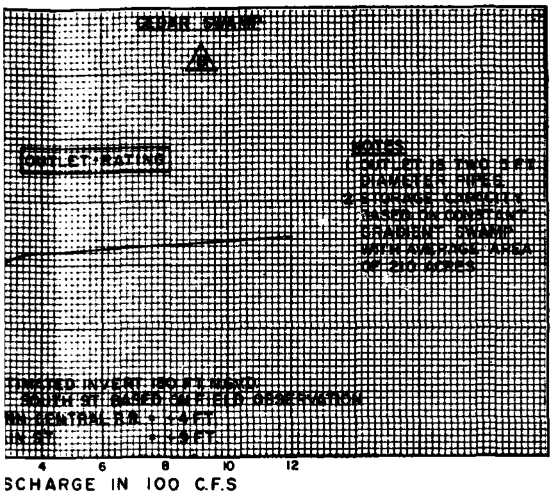

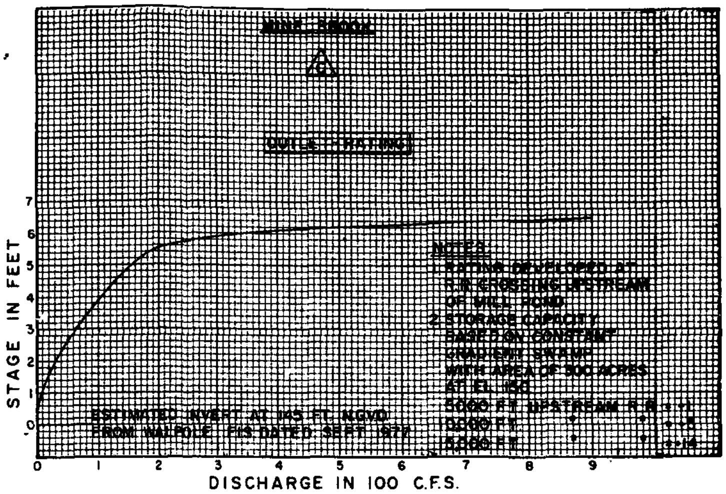

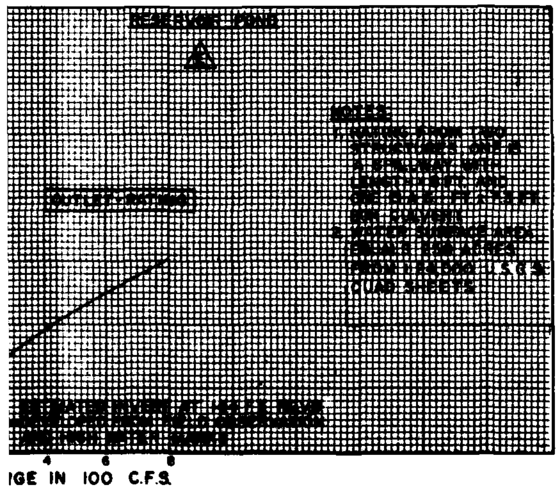

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NEPONSET RIVER BASIN

OUTLET RATING CURVES

AREAS A-B-C-D-E

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GRAPHIC SCALES

2

PLATE C-3

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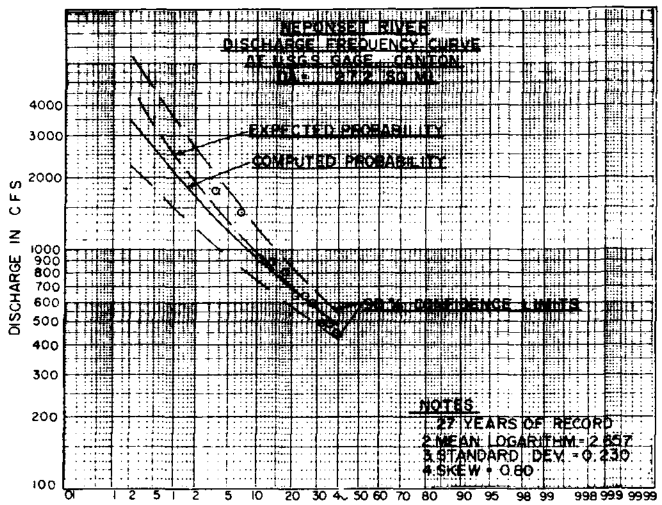

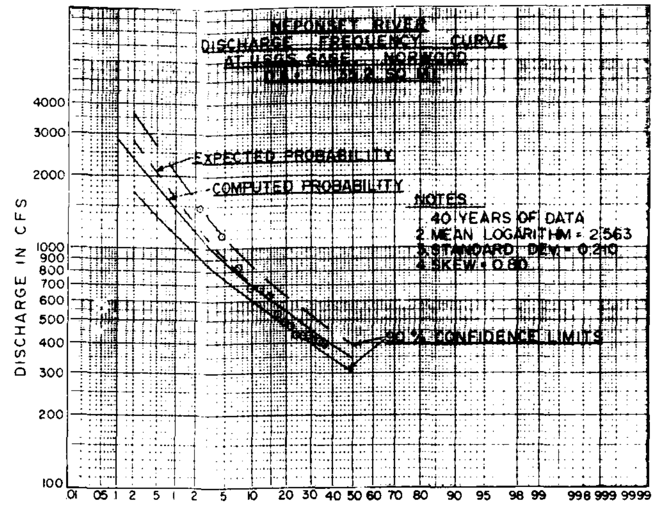

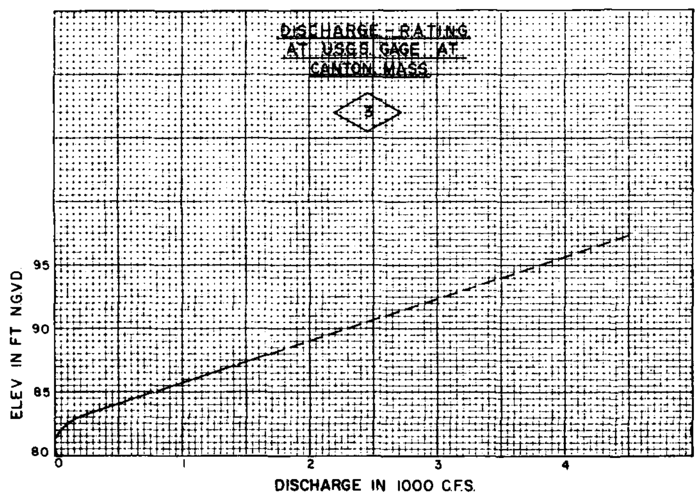

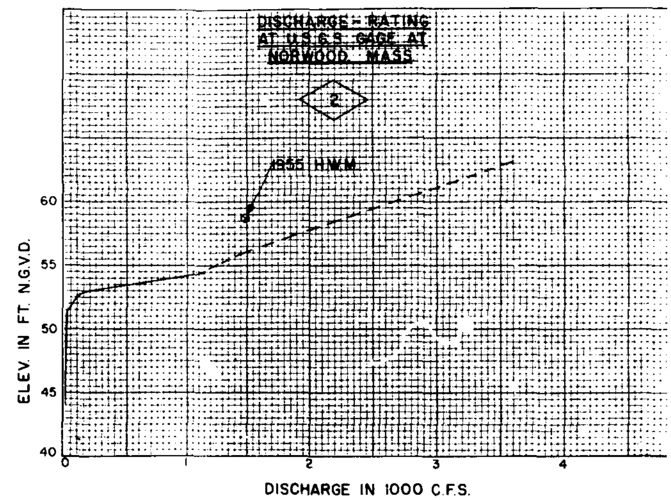

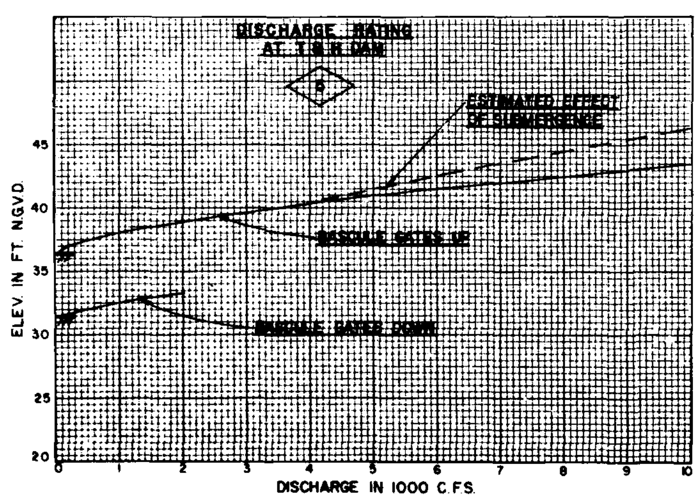

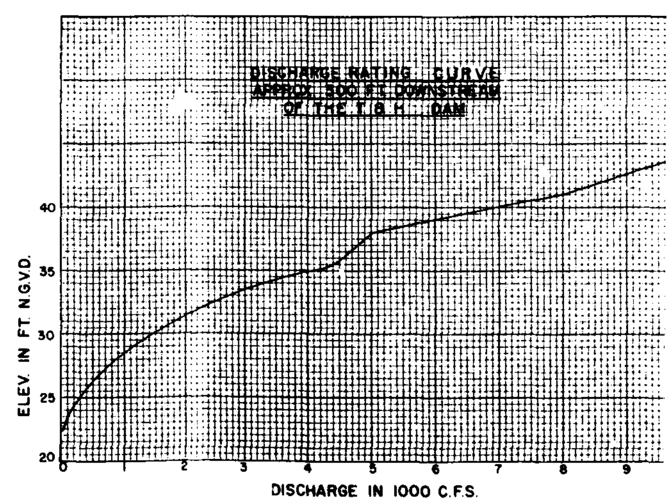

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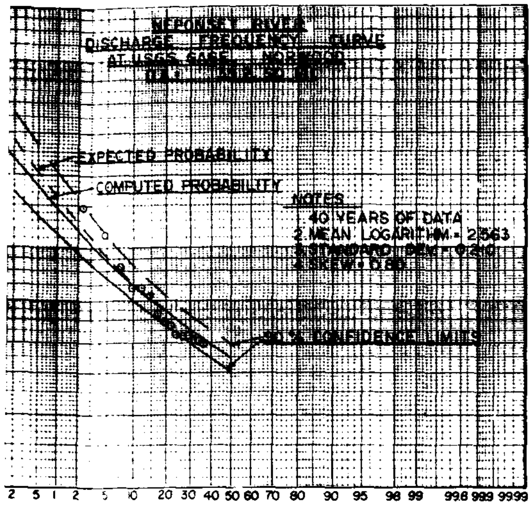

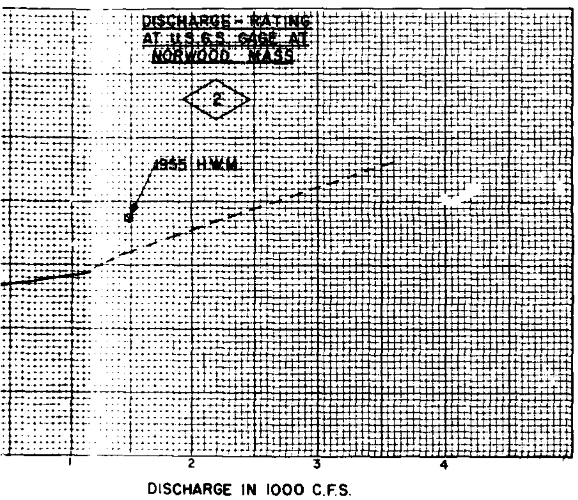

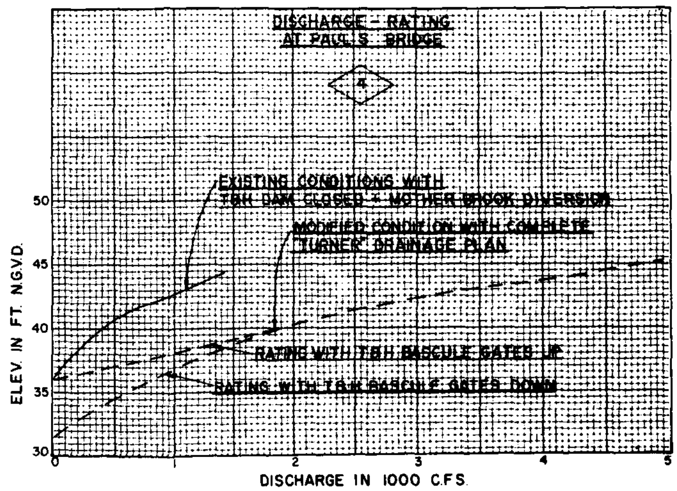

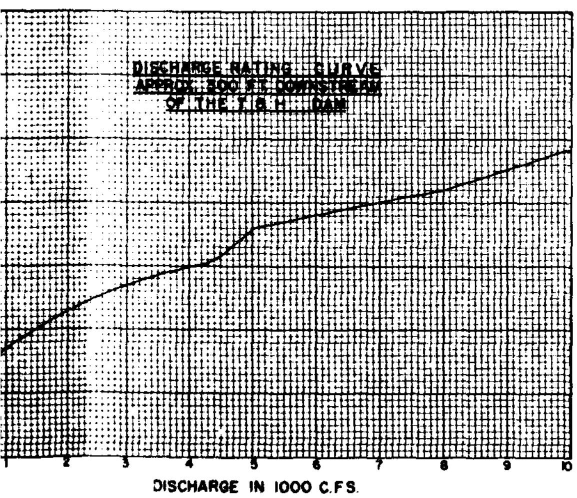

GRAPHIC SCALES

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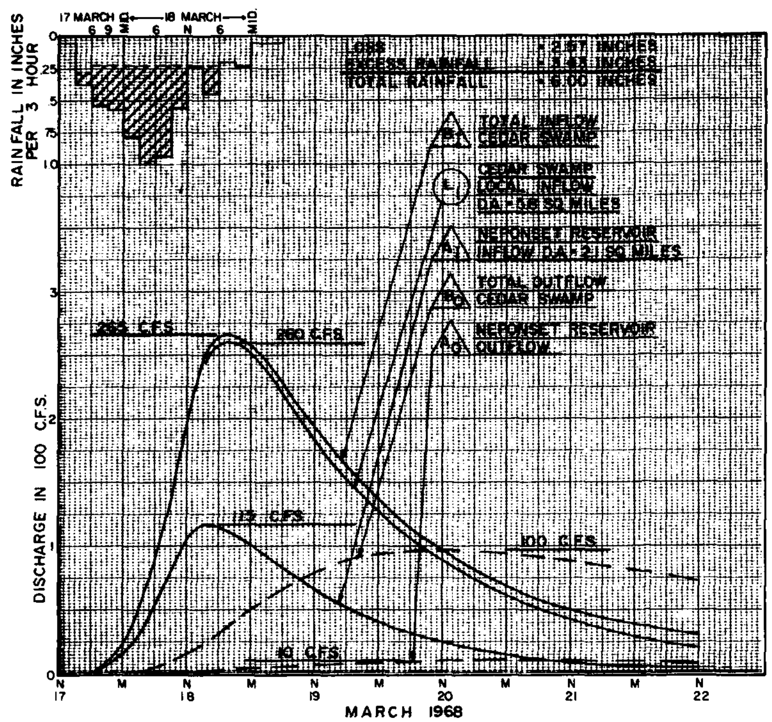
NEPONSET RIVER BASIN

DISCHARGE – FREQUENCY
AND DISCHARGE-RATING CURVE

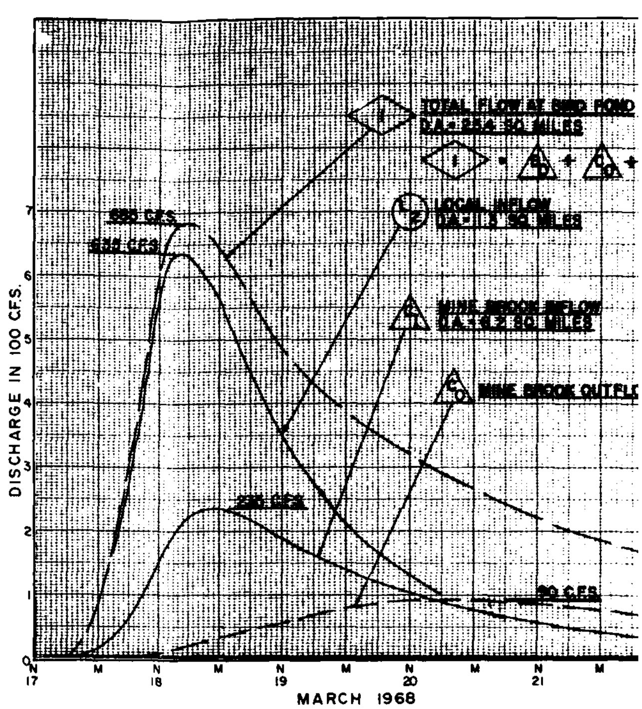
HYDRO. ENG. SECT. MARCH 1981

SCALE | SPEC. NO. | SHEET

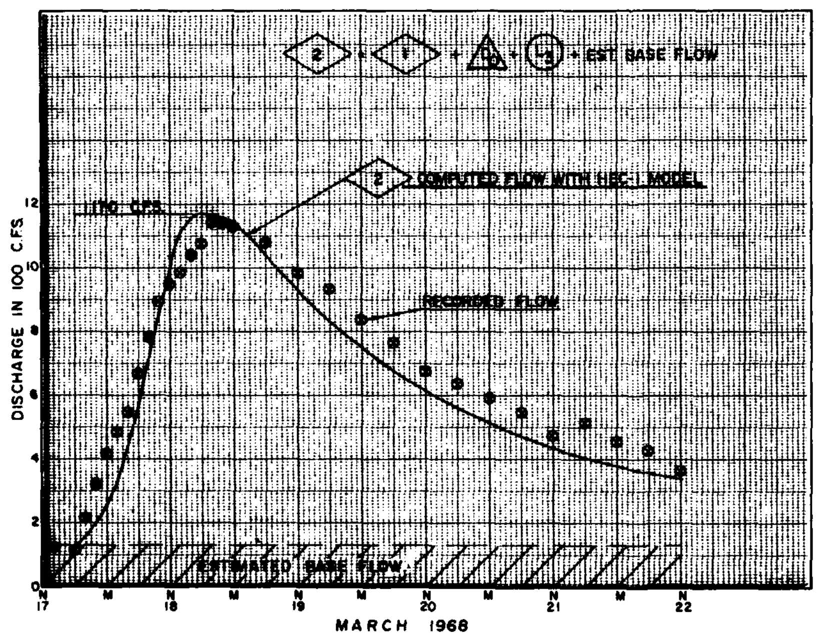
PLATE C-4



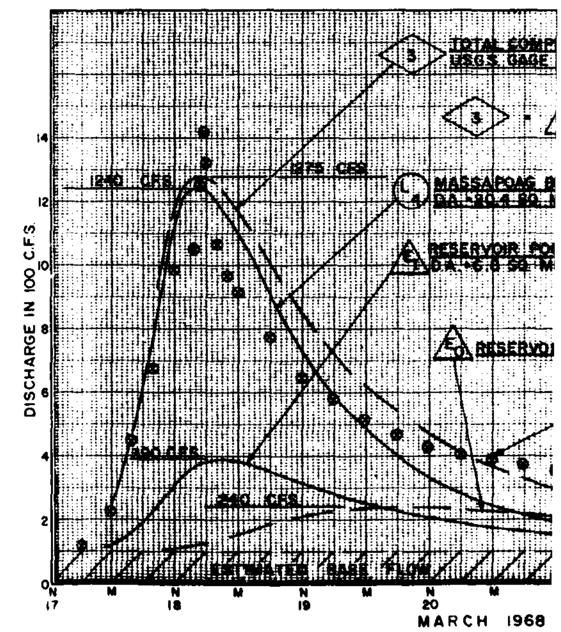
NEPONSET RESERVOIR
TO CEDAR SWAMP



WALPOLE LOCAL
TO BIRD POND

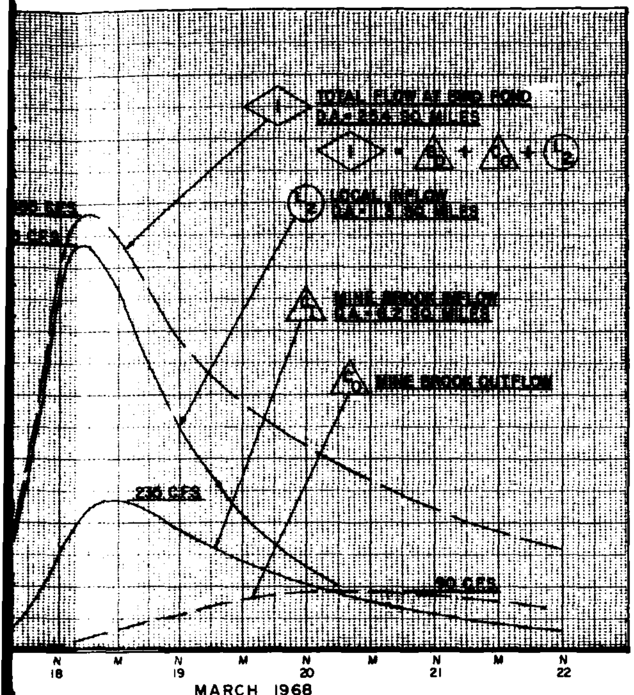


U.S.G.S. GAGE AT NORWOOD
D.A. = 35.2 SQ. MILES

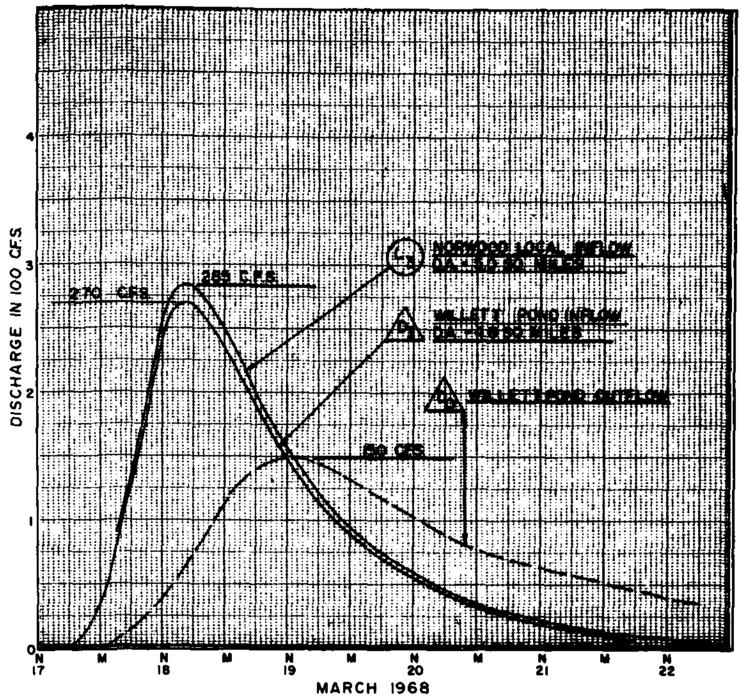


MASSAPOAG BROO
USGS. GAGE AT CAN
(EAST BRANCH NEPONSE

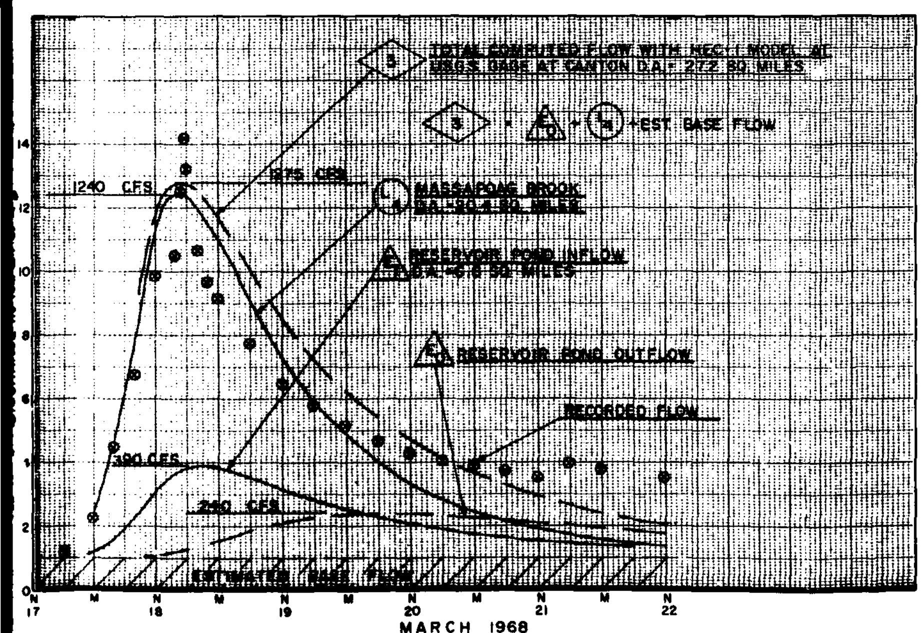
U. S. ARMY



WALPOLE LOCAL
TO BIRD POND



WILLETT POND TO THE
MOUTH OF HAWES BROOK



MASSAPOAG BROOK TO
USGS. GAGE AT CANTON
(EAST BRANCH NEPONSET RIVER)

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NEPONSET RIVER BASIN

MARCH 1968 FLOOD ANALYSIS

TO NORWOOD AND CANTON GAGES

HYDRO. ENG. SECT. MARCH 1981

APPROVED DATE

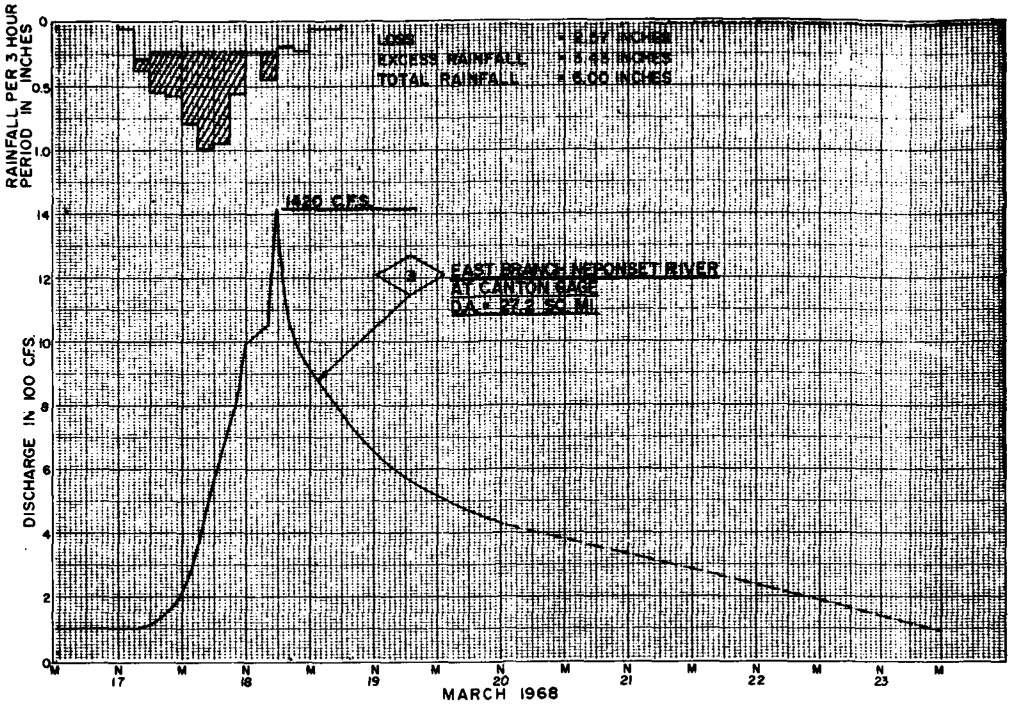
SCALE SPEC. NO.

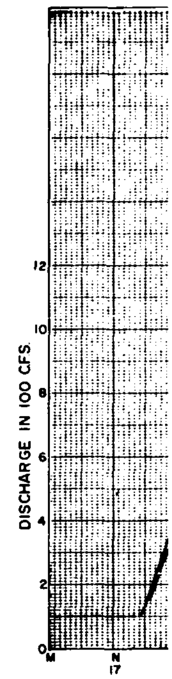
DRAWING NUMBER

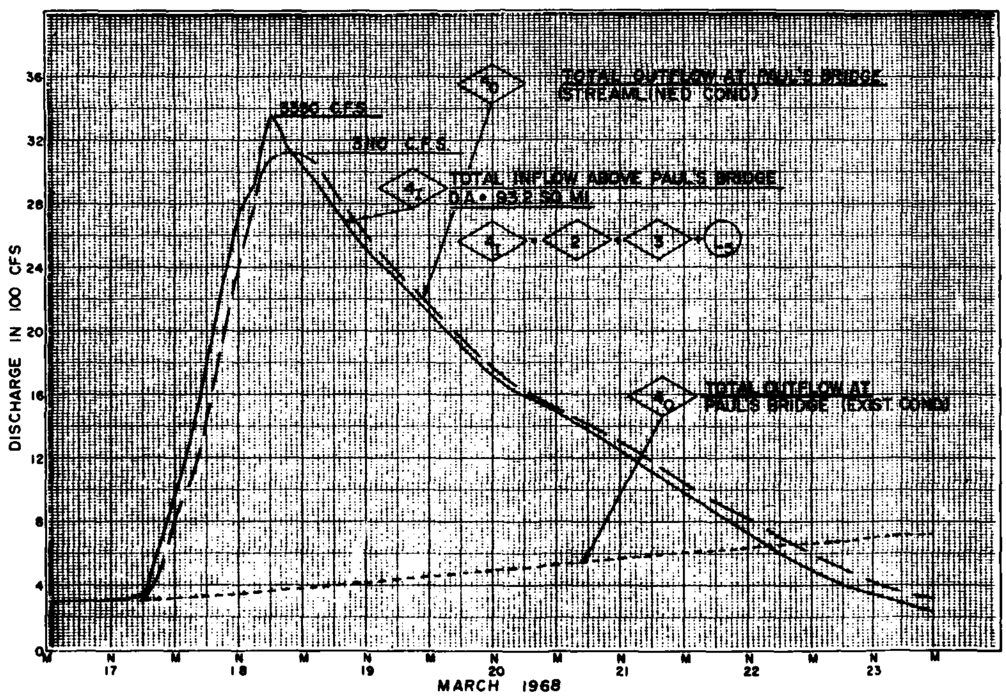
SHEET

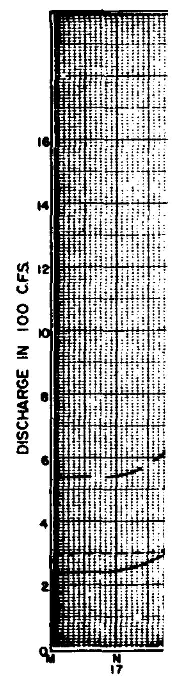
PLATE C-5

CORPS OF ENGINEERS









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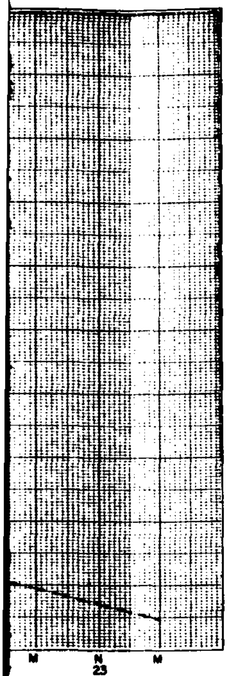

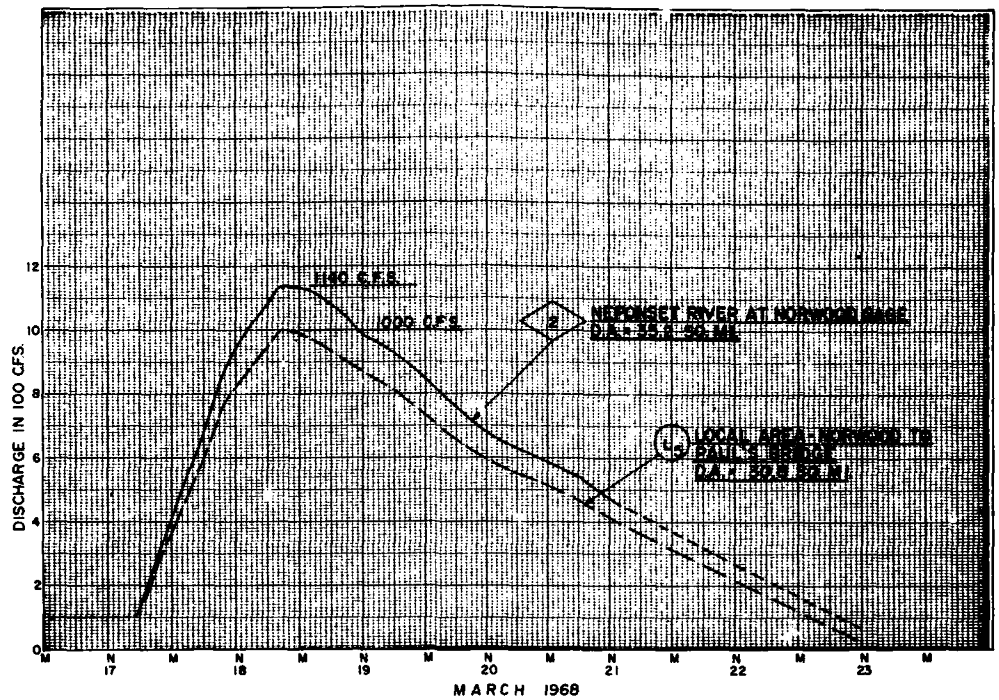

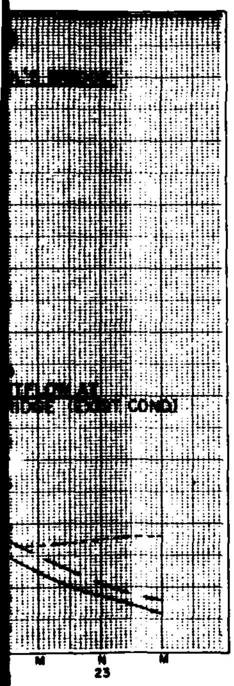

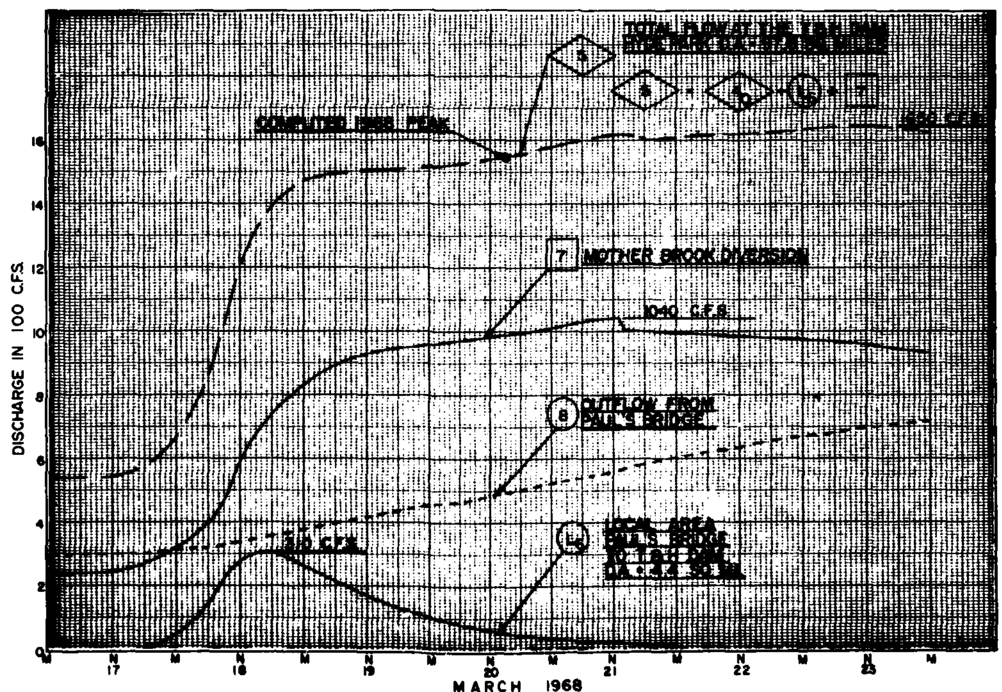

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NEPONSET RIVER BASIN

MARCH 1968 FLOOD ANALYSIS

FOWL MEADOW STORAGE

HYDRO. ENG. SECT. MARCH 1981

2

PLATE C-6

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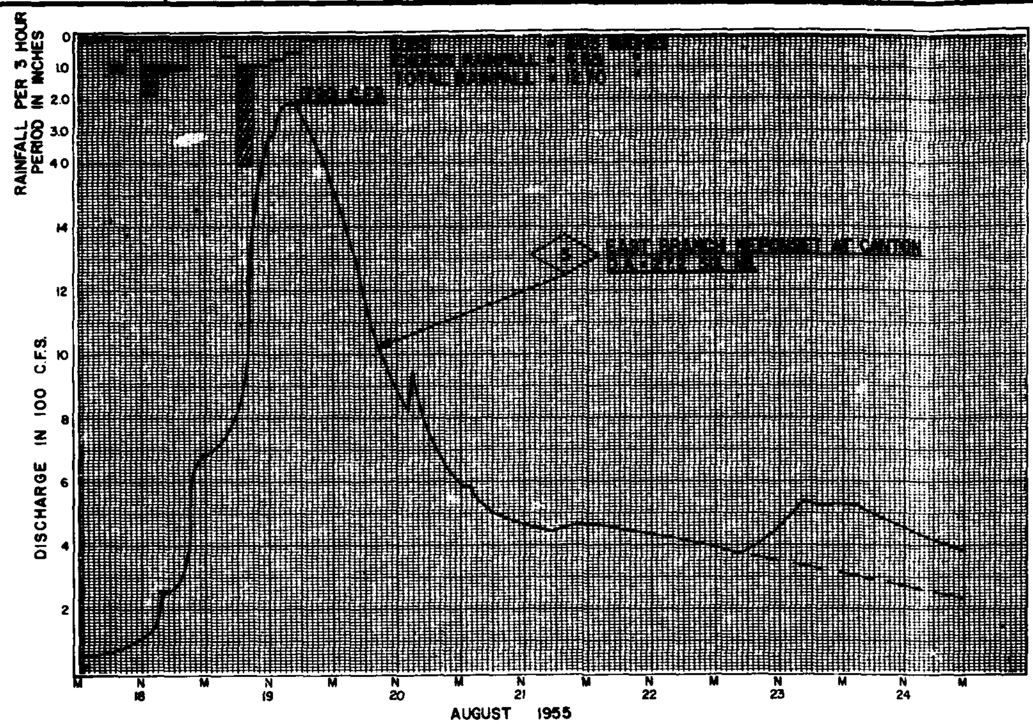

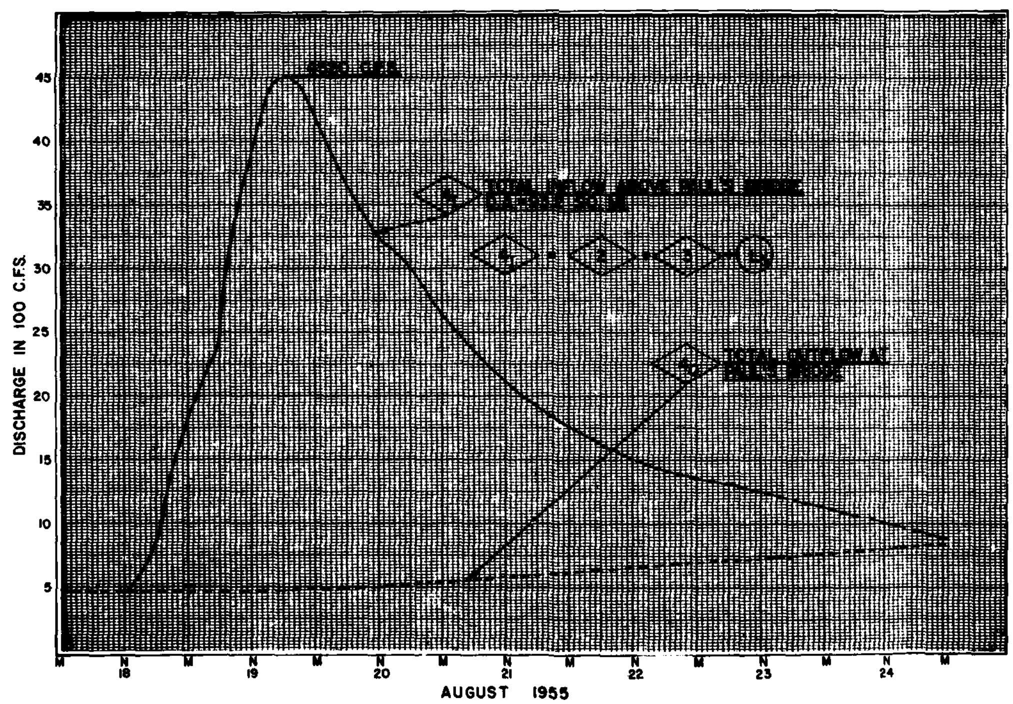

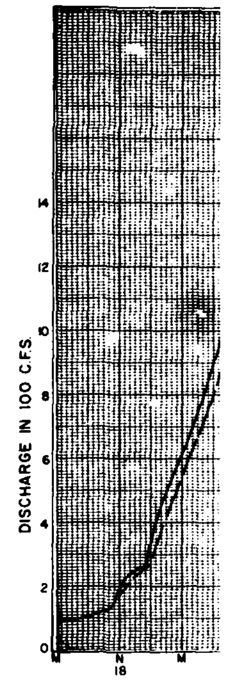

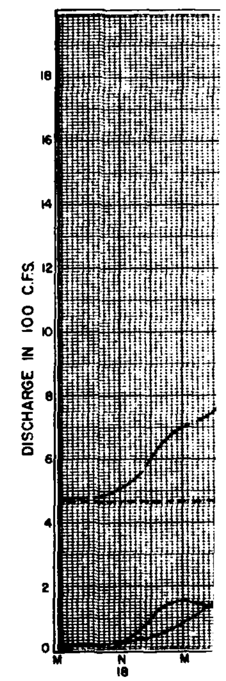

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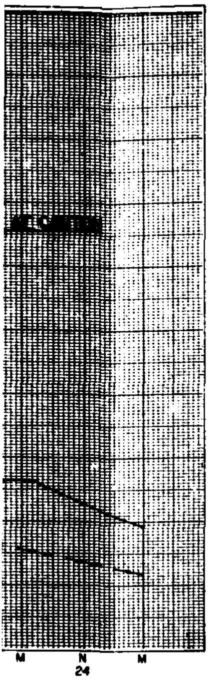

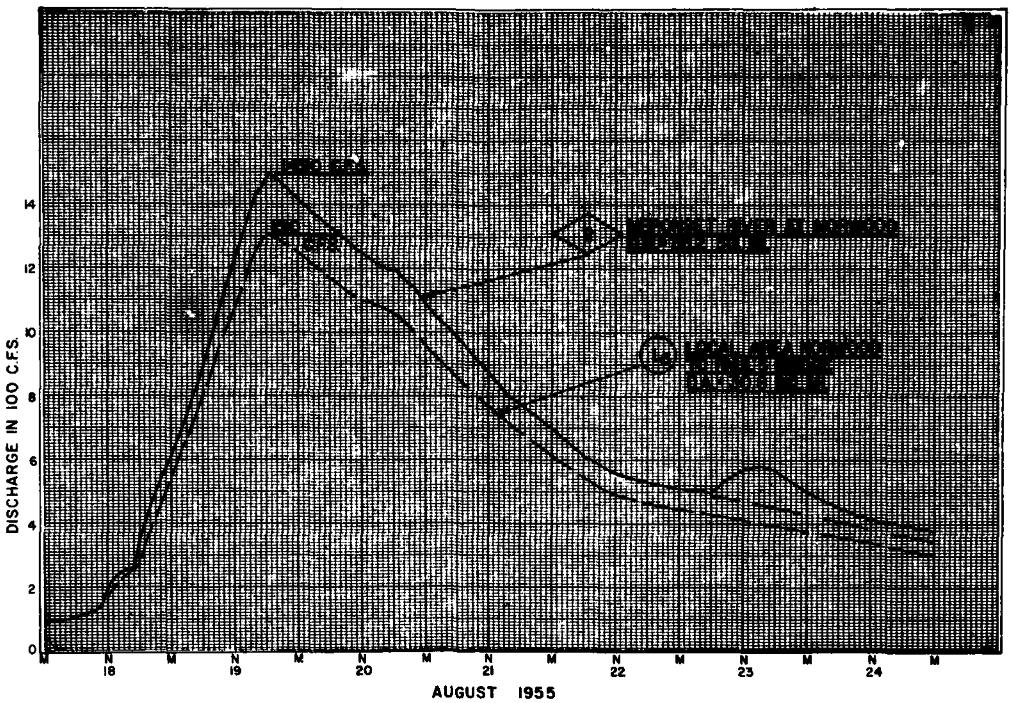

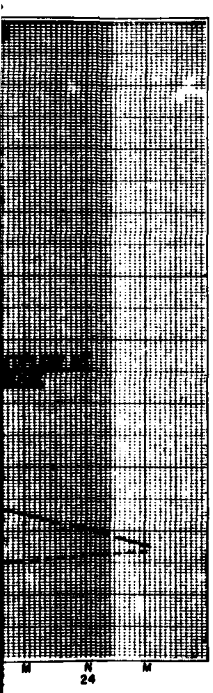

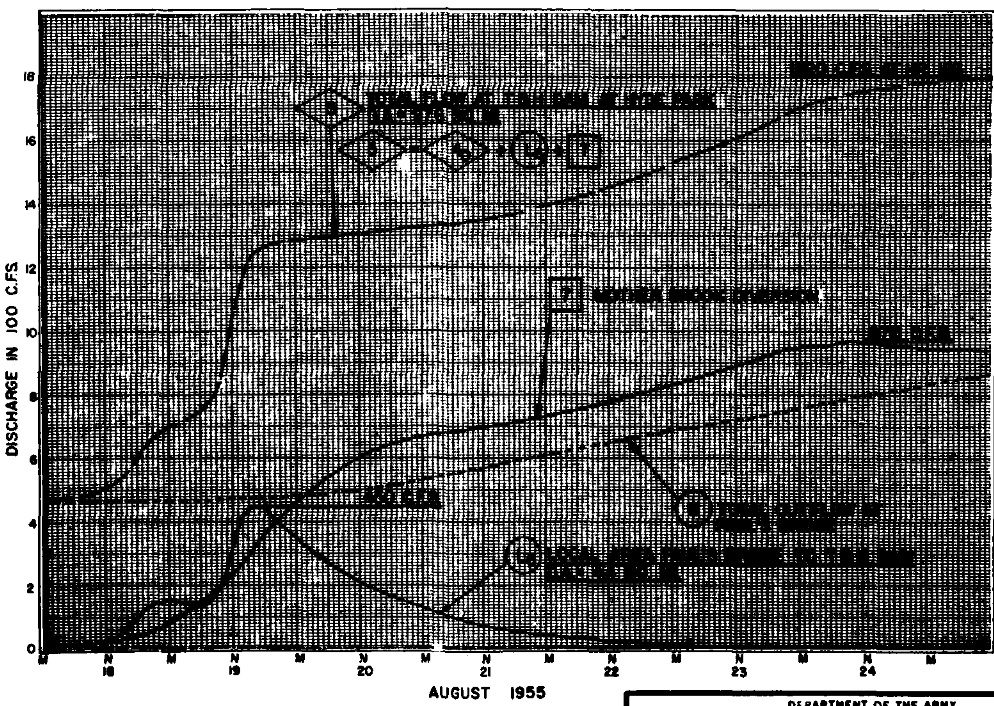

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WALTHAM, MASS.

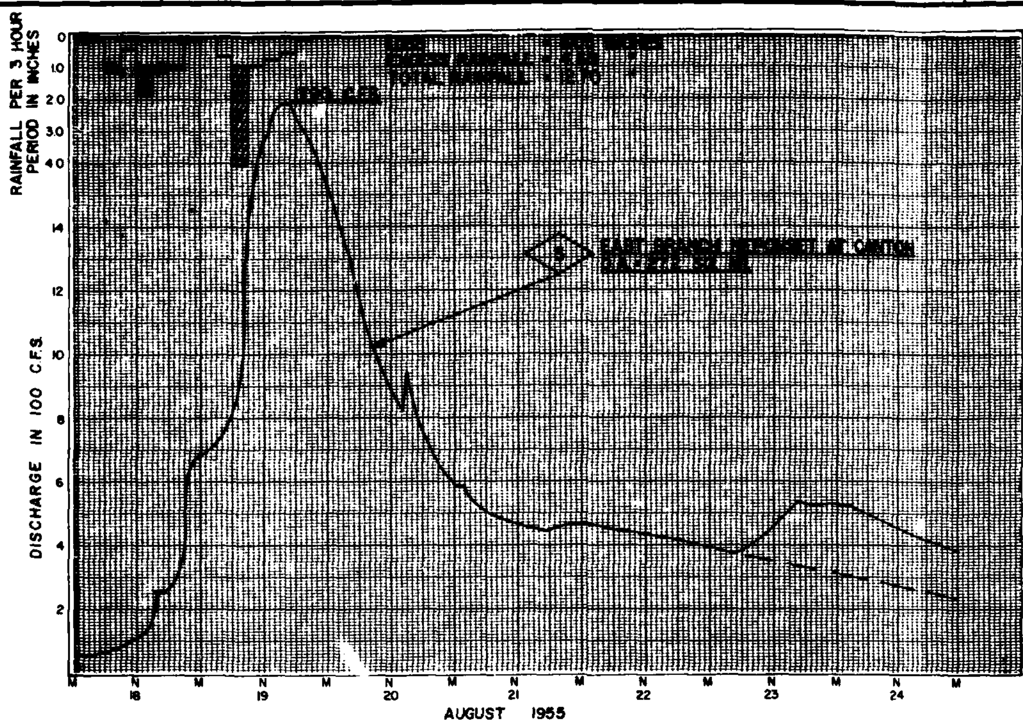
NEPONSET RIVER BASIN
RECURRING AUGUST 1955
FLOOD ANALYSIS
FOWL MEADOW STORAGE

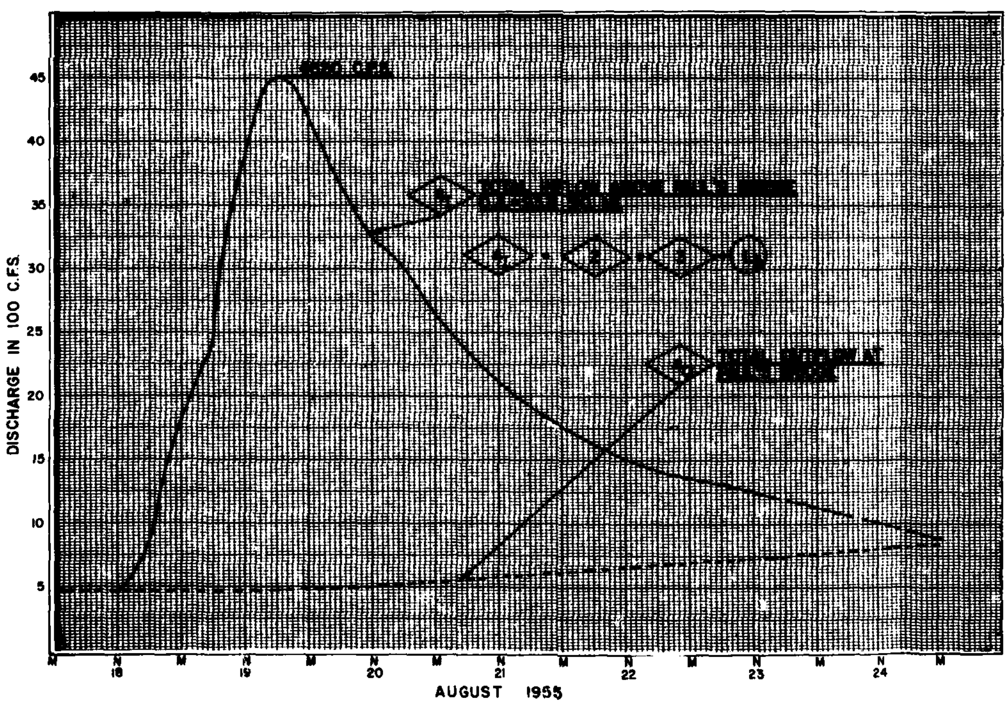
HYDRO. ENG. SECT. MARCH 1981

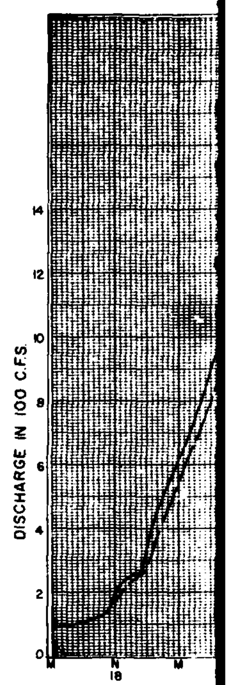
SHEET

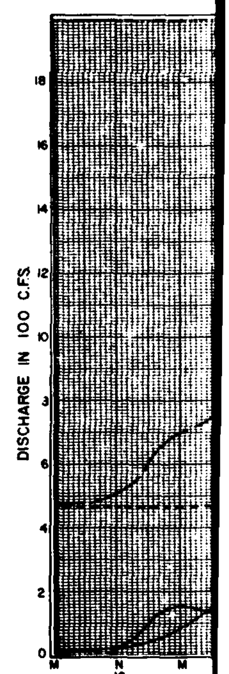
PLATE C-7

CORPS OF ENGINEERS









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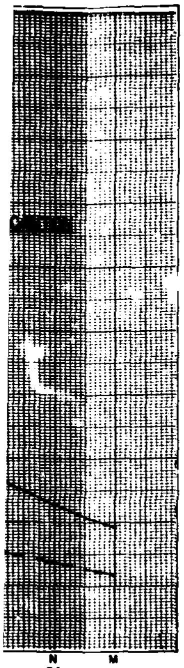

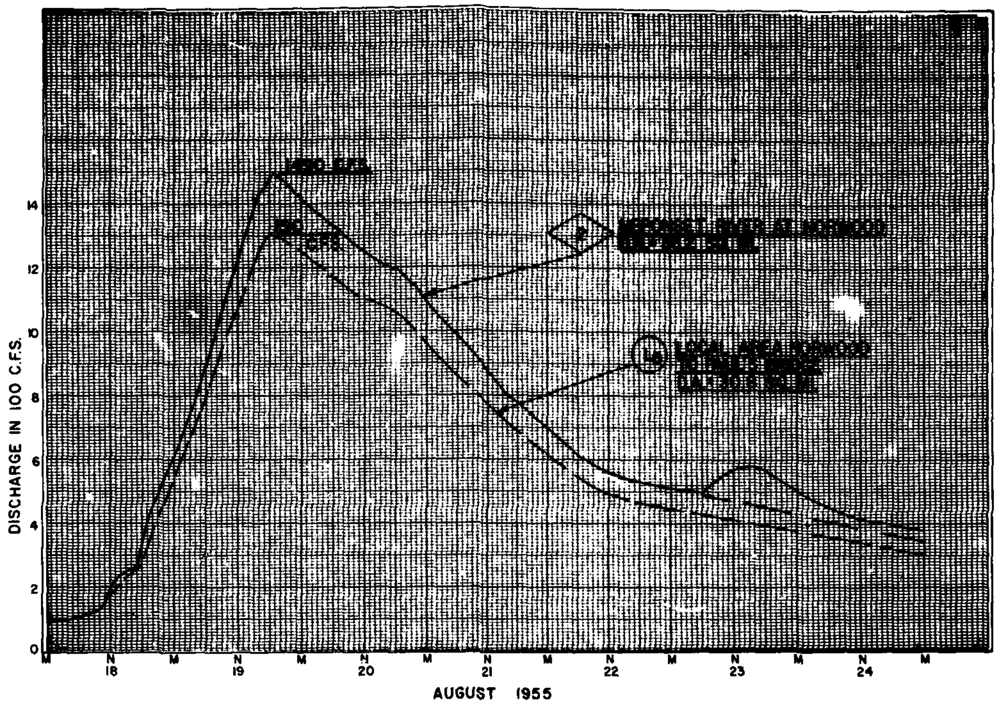

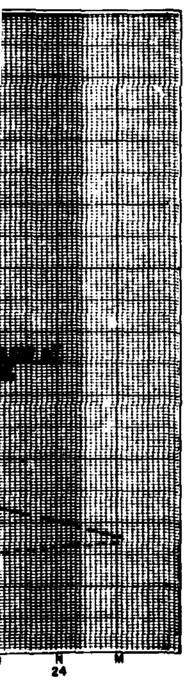

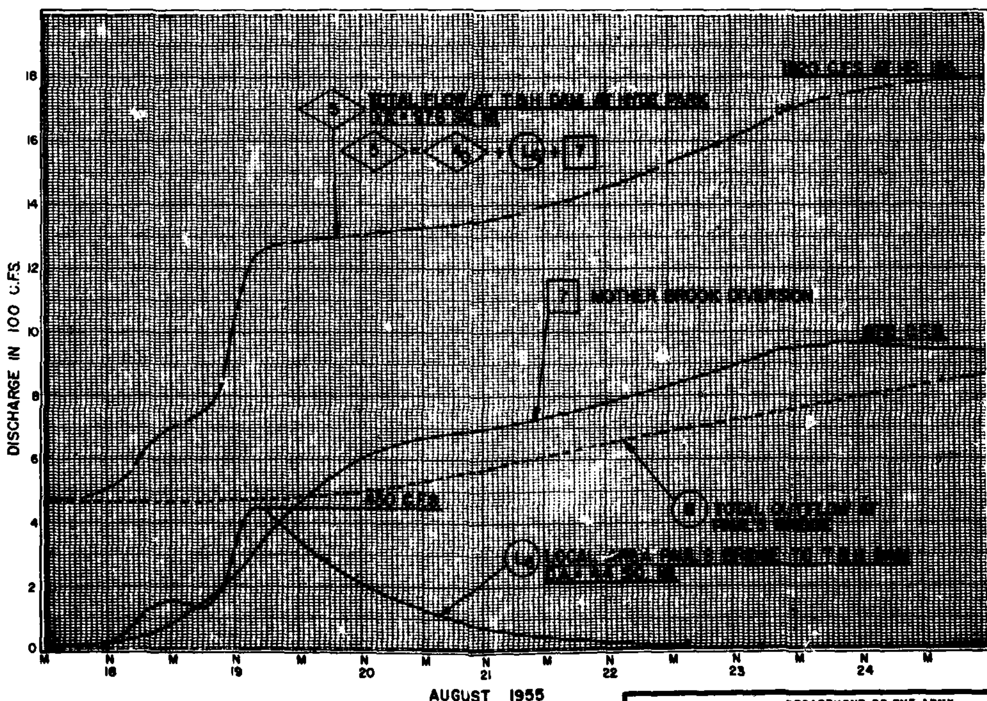

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NEPONSET RIVER BASIN
RECURRING AUGUST 1955
FLOOD ANALYSIS
FOWL MEADOW STORAGE

HYDRO. ENG. SECT. MARCH 1981

2

PLATE C-7

In analyzing this most important but complex storage area, it was necessary to consider both the hydraulic conveyance and hydrologic storage aspects of the reach and the effects that any encroachment or channelization might have on both. The relatively new Fred model, "Dam Break Flood Forecasting Model" was employed because it has the unique capability of routing a flood hydrograph through a river reach using both these characteristics. The dynamic unsteady flow routing is performed by a "honing" iterative process governed by the requirements of both the principle of the conservation of mass and the principle of the conservation of momentum. The analysis provides output on the attenuation of the flood peak, resulting flood stages and, timing of the flood as it progresses downstream.

Historically the T&H Dam was equipped with permanent flashboards, with a top elevation at approximately 41 feet NGVD. Following the 1955 flood as part of the "Turner" plan, the dam was equipped with two 70 foot long, 5 foot high, bascule gates. The top elevation of these gates is now about 36.5 feet NGVD and the fully lowered elevation about 31.5 NGVD. The hydraulic rating at the dam was based on one gate at 36.5 feet NGVD and the other at 36.1 feet NGVD. This was the reported positioning during the March 1968 flood event. Manning's roughness coefficients ranged from 0.04 to 0.07. The developed Fred model was calibrated against its ability to reasonably reproduce the experienced 1968 flood levels. The computed 1968 hydrographs are shown on Plate C-6. The computed profile and the recorded highwater elevations are shown on Plate C-8. Once calibrated, the Fred model could be used to effectively analyze the hydraulic and hydrologic effect of various actions in the Fowl Meadow.

9. ANALYSIS OF FLOODS

Four floods were analyzed using the developed HEC-1 and Fred models. The floods were the March 1968 and August 1955 historic floods and the 100-year and standard project synthetic floods. Analyses were made with the HEC-1 model, both with and without the identified storage areas, in order to assess the effects of such storage on downstream peak flows. The Fred model was used in analyzing the effects of the Fowl Meadow flood plain both hydrologically and hydraulically under existing conditions and under modified conditions. Comparative data for all four flood analyses is summarized in Tables C-8 through C-11. The March 1968 flood analysis is graphically illustrated on Plate C-5. Following is a brief discussion of each of the floods.

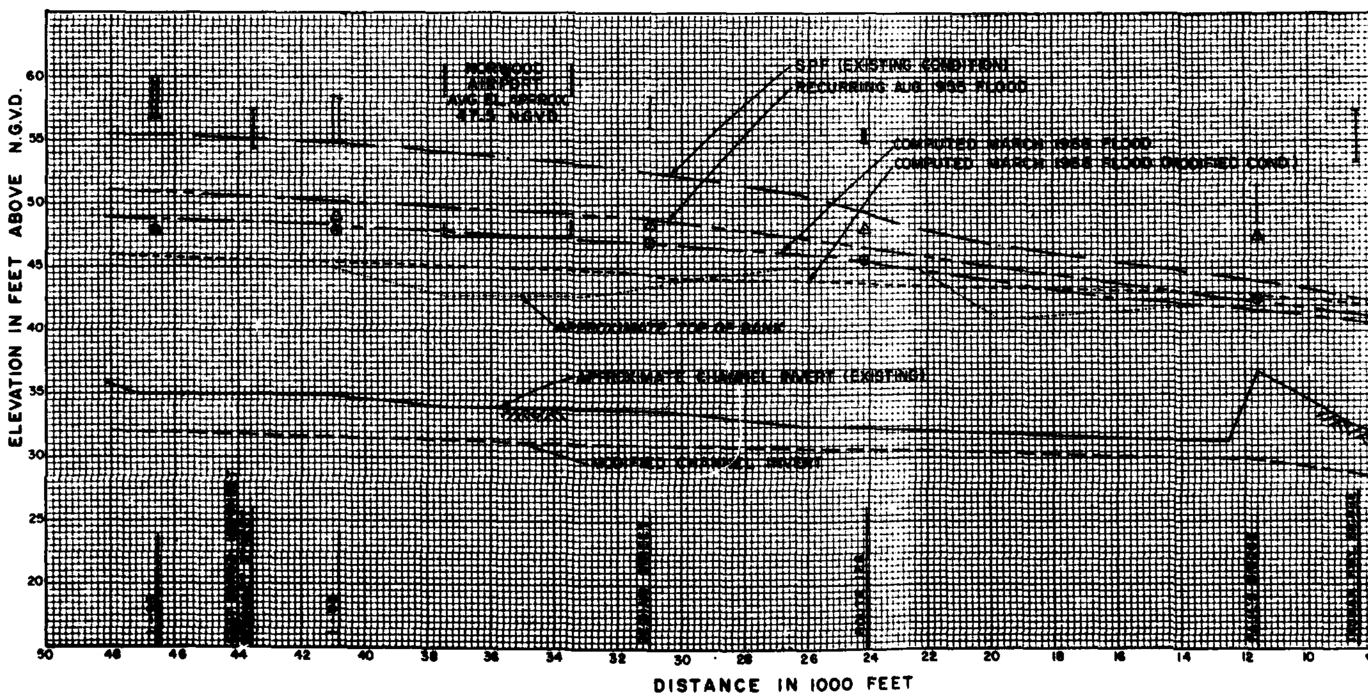
a. August 1955 Flood - The flood of record in the Neponset River Basin occurred in August 1955 as a result of a total storm rainfall on the 18th, and 19th of about 12.0 inches, with about 4 inches occurring in a 3 hour period on the 19th. This storm produced about 4.6 inches of excess rainfall-runoff, and only because the storm occurred during a low antecedent season was the excess and resulting flood not greater. Based on the HEC-1 analysis, depths of surcharge storage in areas "A" through "D" ranged from 2 to 5 feet representing approximately 2,300 acre-feet of storage over an area of about 1,000 acres. This storage provided about a 1,900 cfs or 35 percent reduction in the flow at the gage in Norwood!

TABLE C-8

NEPONSET RIVER
AUGUST 1955 FLOOD ANALYSIS
RAINFALL EXCESS = 4.6 INCHES

Storages					Locals		Indexes					
							Existing			Unmodified by Storage		
Site	Inflow (cfs)	Outflow (cfs)	Storage (ac-ft)	Stage (ft)	Site	Flow (cfs)	Site	Flow (cfs)	Stage (ft)	Flow (cfs)	Stage (ft)	
A	170	15	420	260.4	L_1	370	1	1,000	-	1,760	-	
B	375	135	750	182.5	L_2	920	2	1,665	56.6	2,570	59.6	
C	330	140	710	109.9	L_3	410	3	1,610	88.5	2,000	89.4	
D	390	210	450	142.8	L_4	1,660	4	970	42.5	6,900		
								(1,000)	42.6			(Fowl Meadow Storage, No Upstream Storage)
E	410	200	680	146.4	L_5	1,310		(4,120)	43.9			(Fowl Meadow Fully Streamlined)
Fowl Meadow	4,500	970	14,900	42.5	Mother Brook	970	5	1,820	38.8	7,300	43.8	
								(1,900)	38.8			(Fowl Meadow Storage, No Upstream Storage)
								(4,570)	41.1			(Fowl Meadow Fully Streamlined)
					L_6	450						

CORPS OF ENGINEERS



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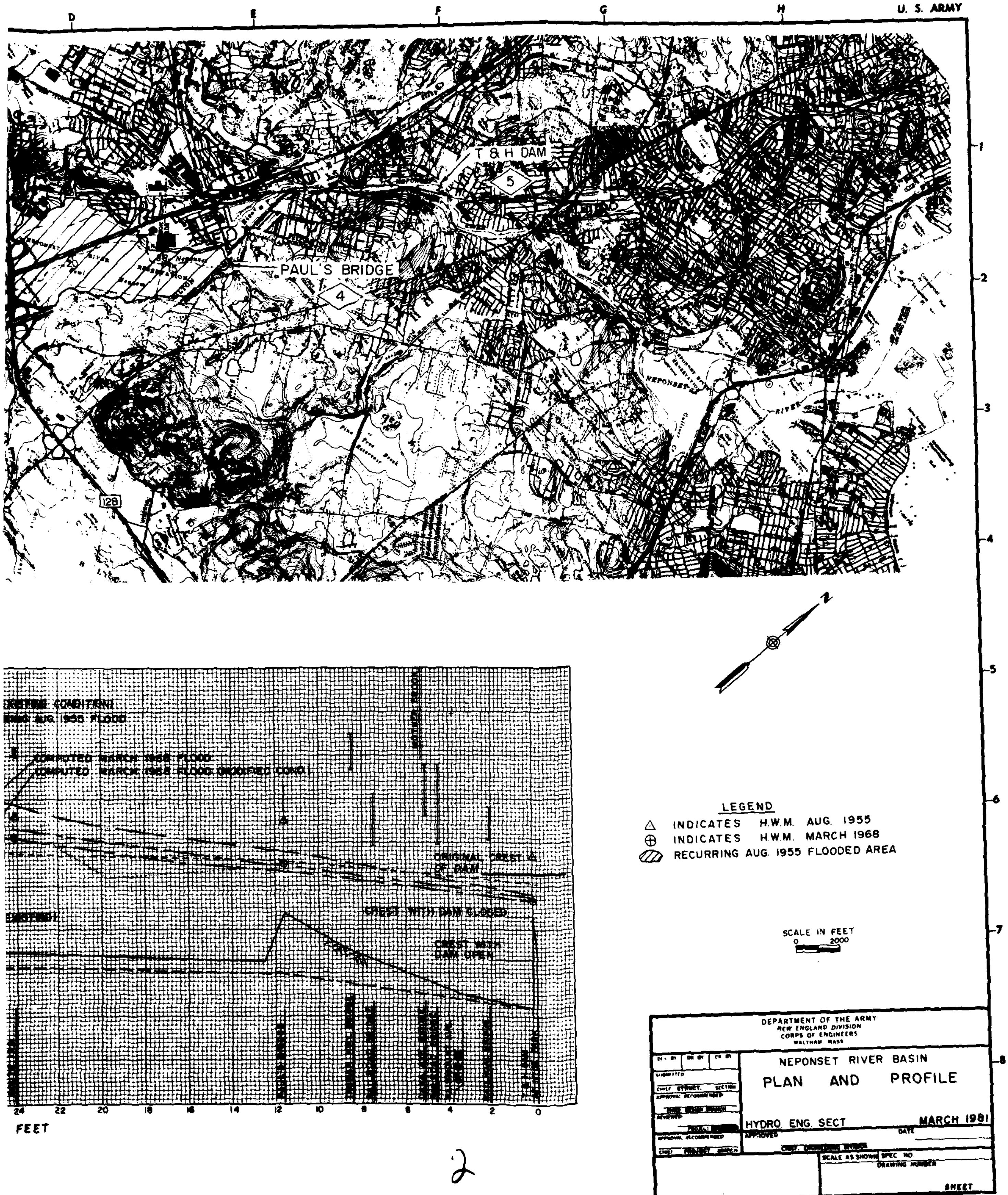
U. S. ARMY
D
E
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T & H DAM
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PAUL'S BRIDGE
4
NEPONSET
RIVER
128
N
CONDITION
AUG. 1955 FLOOD
COMPUTED MARCH 1968 FLOOD
COMPUTED MARCH 1968 FLOOD (MODIFIED COND.)
ORIGINAL CREST OF DAM
CREST WITH DAM CLOSED
CREST WITH DAM OPEN
24
22
20
18
16
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12
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2
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FEET
LEGEND
INDICATES H.W.M. AUG. 1955
INDICATES H.W.M. MARCH 1968
RECURRING AUG. 1955 FLOODED AREA
SCALE IN FEET
0
2000
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.
NEPONSET RIVER BASIN
PLAN AND PROFILE
HYDRO. ENG. SECT.
MARCH 1981
DATE
APPROVED
SCALE AS SHOWN
SPEC. NO.
DRAWING NUMBER
SHEET

PLATE C-8

2

TABLE C-9

NEPONSET RIVER
MARCH 1968 FLOOD ANALYSIS
RAINFALL EXCESS = 3.4 INCHES

Storages					Locals		Indexes					
							Existing			Unmodified by Storage		
Site	Inflow (cfs)	Outflow (cfs)	Storage (ac-ft)	Stage (ft)	Site	Flow (cfs)	Site	Flow (cfs)	Stage (ft)	Flow (cfs)	Stage (ft)	
A	115	10	315	269.1	L_1	260	1	690	-	1,230	-	
B	265	100	560	182.0	L_2	635	2	1,170	54.7	1,780	57.0	
C	235	90	560	149.0	L_3	280	3	1,275	86.6	1,420	87.1	
D	270	150	360	142.5	L_4	1,140	4	720	41.8	5,100		
								(820)	42.1			(Fowl Meadow Storage, No Upstream Storage)
E	290	140	530	146.0	L_5	1,000		(3,130)	42.7			(Fowl Meadow Fully Streamlined)
Fowl Meadow	3,440	720	12,600	41.8	Mother Brook	1,040	5	1,650	38.6	5,840	42.4	
								(1,740)	38.65			(Fowl Meadow Storage, No Upstream Storage)
								(3,930)	40.4			(Fowl Meadow Fully Streamlined)
					L_6	310						

TABLE C-10

NEPONSET RIVER
100-YEAR FREQUENCY SYNTHETIC FLOOD
RAINFALL EXCESS = 4.9 INCHES

Storages					Locals		Indexes: Existing			Indexes: Unmodified by Storage		
Site	Inflow (cfs)	Outflow (cfs)	Storage (ac-ft)	Stage (ft)	Site	Flow (cfs)	Site	Flow (cfs)	Stage (ft)	Flow (cfs)	Stage (ft)	
A	190	15	440	269.4	L_1	415	1	1,110	-	1,960	-	
B	420	145	800	182.7	L_2	1,045	2	1,790	57.0	3,000	61.0	
C	365	150	740	150.0	L_3	470	3	2,020	89.2	2,420	90.5	
D	445	230	480	143.0	L_4	1,875	4	960	42.5	8.050		
								(1,000)	42.6			(Fowl Meadow Storage, No Upstream Storage)
E	460	220	710	146.6	L_5	1,590		(4,950)	45.3			(Fowl Meadow Fully Streamlined)
Fowl Meadow	5,490	960	19,800	42.5	Mother Brook	1,000	5	1,960	38.8	8,850	45.3	
								(2,000)	38.8			(Fowl Meadow Storage, No Upstream Storage)
								(5,870)	42.3			(Fowl Meadow Fully Streamlined)
					L_6	340						

TABLE C-11

NEPONSET RIVER
STANDARD PROJECT FLOOD
RAINFALL EXCESS = 8.7 INCHES

Storages					Locals		Indexes					
							Existing			Unmodified by Storage		
Site	Inflow (cfs)	Outflow (cfs)	Storage (ac-ft)	Stage (ft)	Site	Flow (cfs)	Site	Flow (cfs)	Stage (ft)	Flow (cfs)	Stage (ft)	
A	355	35	770	270.5	L_1	855	1	2,030	-	3,770	-	
B	775	250	1,430	183.9	L_2	1,940	2	3,250	62.0	5,440	69.3	
C	670	350	1,060	151.0	L_3	865	3	3,650	94.5	4,370	97.0	
D	820	475	750	144.1	L_4	3,490	4	1,300	44.0	14,460		
								(1,410)	44.4			(Fowl Meadow Storage, No Upstream Storage)
E	830	430	1,150	148.0	L_5	3,190		(8,710)	48.5			(Fowl Meadow Fully Streamlined)
Fowl Meadow	9,750	1,300	34,800	44.0	Mother Brook	1,000	5	2,300	39.2	15,060	49.2	
								(2,410)	39.3			(Fowl Meadow Storage, No Upstream Storage)
								(9,400)	45.6			(Fowl Meadow Fully Streamlined)
					L_6	590						

In summary, the average modification in peak flow per acre-foot of storage was about 0.4 cfs/acre-foot or the increase in stage at the Norwood gage site would be about 0.0014 feet per acre-foot of effective storage loss! On the East Branch, it was computed that storage "E," had about 2.4 feet of surcharge representing about 600 acre-feet of storage. This storage alone provided about a 270 cfs or 12 percent reduction in peak flow at the East Branch gage! Modification was about 0.4 cfs per acre-foot of storage or about 0.0014 feet stage reduction per acre-foot of effective storage.

Water levels in the Fowl Meadow rose 8 to 10 feet above normal or about 5 feet over the Meadow, representing storage of about 15,000 acre-feet. Peak inflow to the Fowl Meadow storage, including Mother Brook diversions was estimated at about 5,300 cfs, and peak outflow at the T&H Dam was about 1,800 cfs - a 66% reduction!

The 1955 flood occurred prior to the modification of the T&H Dam. In a recurrence of the 1955 flood with the new dam and completed channel improvements, flood stages would be reduced about 5 feet at the dam with lesser reduction progressing upstream, as shown on Plate C-8. If the Fowl Meadow drainage plan had been fully implemented, it is estimated that recurring peak outflows would be in the order of 4,500 cfs. It is noted that this peak flow, under improved conditions was similar in magnitude to that estimated by Turner for a major flood, but is 2.3 times greater than what would occur under existing conditions with storage preservation in the Fowl Meadow! Discharge reduction per unit storage in Fowl Meadow was in the order of 0.25 cfs per acre-foot of storage.

The August 1955 flood was considered to be slightly greater than a 100-year frequency event. The August 1955 flood data is graphically illustrated on Plates C-7 and C-8.

b. March 1968 Flood - The March 1968 flood was the second greatest flood of record and the greatest on the Neponset River since modifications to the T&H Dam and channel improvements in the vicinity of the dam. This flood was the result of a total storm rainfall of over 7 inches on the 17th and 18th. Though the rainfall total was only about 50 percent of that of August 1955, it occurred with a very high antecedent condition resulting in about 3.4 inches of excess runoff or about 70 percent of the runoff of August 1955.

The gates at the new dam were kept up during this flood. According to the Fred model, had the gates been down, the peak discharge would have been an estimated 1,710 cfs or about 10 percent greater than experienced. Flood stage reductions would have varied from about 5.5 feet at the dam to 0.3 feet at Paul's Bridge. Stage reduction would be minimized progressing upstream. With full implementation of the Turner drainage plan the peak outflow would have been an estimated 3,900 cfs! The flood profile is shown on Plate C-8.

c. 100-year Synthetic Flood. The 100-year synthetic flood was developed by obtaining 100-year rainfall data for the area, from the U.S. Weather Bureau Publication T.P. #40, and applying this rainfall to the developed hydrologic models. The maximum 100-year rainfalls for various durations were averaged to provide a "balanced" storm pattern. Rainfall excess was computed assuming a uniform loss rate of 0.2 inch per 3 hour period. The results of the flood analysis is summarized in Table C-10. The developed 100-year synthetic rainstorm data is listed in Table C-12.

d. Standard Project Flood. A standard project flood (SPF) was developed and analyzed for the Neponset basin by applying standard project rainfall to the adopted HEC-1 and Fred models. The SPF represents the flood that might be expected from the most severe combination of meteorologic and hydrologic conditions that are considered reasonably characteristic of the study area, excluding extremely rare combinations. The Standard Project storm rainfall for the Neponset watershed, as determined from EM 1110-2-1411, is 11.1 inches. This resulted in a 24 hour rainfall excess of 8.7 inches, assuming a uniform loss rate of 0.1 inches per hour. The resulting flood data and flood profile through the Fowl Meadow is shown in Table C-11 and Plate C-8, respectively. The standard project rainfall and storm distribution is listed in Table C-13.

10. EFFECTS OF FLOOD STORAGE.

Before high rates of runoff can occur from a watershed, following intense rainfall and/or snowmelt, a depth or volume of water is required to provide the hydraulic conveyance. This principle applies whether the watershed is the Neponset Basin or a paved parking lot. This hydraulic requirement for runoff to occur involves temporary storage which in turn results in lagging and attentuation of runoff. Before a storage reach in the Neponset can discharge a certain magnitude of flow it must be of sufficient hydraulic stage. This required increase in stage results in significant temporary reservoir storage which greatly attenuates peak flood flows - whether it be a river reach, wetland area reservoir, or off-channel flood plain storage.

Change in storage can only occur as a result of change in stage, which in turn is a function of change in flow in the river. The relative effect of flood storage on outflow is therefore dependent on the rate of rise of the flood crest, the amount of storage area, and the magnitude of river flow. During rising flood stages, the outflow from a reach is less than the inflow by an amount equivalent to the rate of rise in stage multiplied by the surface area of the storage. The amount the flood peak is reduced depends on the type of flood and the characteristics of the area.

The storage areas analyzed on the upper Neponset and East Branch Rivers have depths of temporary surcharge storage generally ranging from 2 to 5 feet. It was further determined that this storage provided about a 25 percent reduction in flow at the downstream gages or an average of 0.4 cfs reduction in peak flow for each acre-foot of storage!

TABLE C-12

100-YEAR SYNTHETIC STORM RAINFALL

3 hr Period	Rainfall (Inches)	Losses (Inches)	Excess (Inches)	Rearranged Excess (Inches)
1	2.25	.2	2.05	.08
2	1.60	.2	1.40	.15
3	.83	.2	.63	.32
4	.52	.2	.32	1.40
5	.40	.2	.20	2.05
6	.35	.2	.15	.63
7	.28	.2	.08	.20
8	.28	.2	.08	.08
Total	6.51	1.6	4.91	4.91

TABLE C-13

STANDARD PROJECT FLOOD RAINFALL

3 Hr Period	Rainfall (inches)	Losses (inches)	Rainfall Excess (inches)	Rearranged Excess (inches)
1	2.64	.3	2.34	0
2	5.34	.3	5.04	0
3	.51	.3	.21	.21
4	1.05	.3	.75	.75
5	.50	.3	.20	2.34
6	.50	.3	.20	5.04
7	.28	.28	0	.20
8	.28	.28	0	.20
Total	11.10	2.36	8.74	8.74

In assessing the effect of loss in storage due to development (filling, diking or draining) it is important to realize the significance of the term <u>effective</u> storage loss. When a specific storage is lost there is a resulting increase in downstream flood flows, but there is also an increase in flood stages in adjacent areas. However, the effect of increased stages, due to loss of existing storage, often leads to pressure for remedial channel improvements, filling or diking which can have a compounding storage loss effect much greater than the original increment of storage loss.

Flood analysis of the Fowl Meadow indicated generally 5 to 8 feet of temporary surcharge storage over this area providing about 15,000 to 30,000 acre-feet of storage. This provides a 60 to 70 percent reduction in peak flood flow. This reduction is equivalent to 0.25 cfs reduction per acre-foot of storage. The effect of loss of upstream storage is generally limited to tributary streams to the Fowl Meadow.

Loss of storage in the Fowl Meadow and other wetland areas in the Neponset River Basin would have a significant effect on peak flows downstream, but would also affect flood levels and associated damages in periphery areas. It is for this reason that periodic flood storage should be planned and provided for, with the peripheral areas developed accordingly. There are pressures for more intense development posing a continuing need for planned management and development in the region with due consideration of the hydrologic character of the watershed.

In summary, the Fowl Meadow area is the dominant and centrally located natural storage area in the Neponset Basin. Its storage capacity combined with available upstream storage is adequate for nearly complete control of all flood runoff. The storage in the Fowl Meadow alone is equivalent to about 3 inches of runoff. Existing State and Federal regulations, as well as local ordinances, should be employed throughout the basin for wise management of natural wetland and other detention storage areas.

APPENDIX D

FISH AND WILDLIFE

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
ECOLOGICAL SERVICES
P. O. BOX 1518
CONCORD, NEW HAMPSHIRE 03301

September 21, 1978

Division Engineer
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Sir:

This is our planning aid letter on your water resources management study of the Neporset River Basin, Massachusetts. It is prepared and submitted in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

In spite of its proximity to the Boston urban area, the Neponset River Basin contains a variety of fish and wildlife habitats, which support a diverse population of fish and wildlife species. Slightly over 50% of the basin's area is forested (including wooded wetlands), 3% is wetlands other than wooded wetlands, 8% is agricultural and open, and 2% is open water. These various habitats are the wildlife habitat base or the actual amount of land capable of supporting non-urban wildlife, as well as the amount of habitat potentially usable by people enjoying fish and wildlife. Forest lands, agricultural and open land, wetlands, and open water are the most significant wildlife and fisheries habitats. These types of areas comprise approximately 60% of the basin's total area. Thus, although the basin is highly developed, there is still a significant amount of habitat remaining to support fish and wildlife resources.

Fishery Resources

The fishery resources of the Neponset River Basin provide mainly a warm water fishery. The most common fish species found in the study area are *pumpkinseed, yellow perch, brown bullhead, chain pickerel, golden shiner,* bluegill, largemouth bass, white perch, black crappie, white sucker, and smallmouth bass. They provide a relative abundance of warm water fishing opportunity. Trout are stocked and provide a put-and-take fishery in some of the small feeder streams of the upstream areas of the watershed. In general, the freshwater fishery of the basin is limited by pollution, lack of public access, and low flows.

Significant shad and alewife runs once existed in the Neponset River, but pollution and obstructions to migration have eliminated them. Smelt still use the river below the first dam at Milton Lower Mills, Milton.

Wildlife Resources

The basin supports a wide variety of wildlife species found in southeastern Massachusetts, in spite of the highly urbanized nature of much of the watershed. Ruffed grouse, gray squirrel, cottontail, woodcock, ring-necked pheasant, and various species of waterfowl are distributed widely in the basin, including some of the more heavily urbanized areas. White-tailed deer are present in low numbers in the less heavily urbanized areas. The best quality and greatest quantity of wildlife habitat is found in the upstream portions of the watershed and in the wetlands along the main stem of the river.

Other wildlife species, including muskrat, mink, skunk, fox, raccoon, and beaver, are found within the basin. These do not contribute significantly to the wildlife recreation aspects of the basin, but do give some income to those who trap.

One of the major habitat types of value to wildlife is wetlands. Over 10% of the basin can be classified as wetlands. Because of legal and practical constraints placed on the development of wetlands, many of these areas remain intact and provide refuge for numerous wildlife species. Most of the basin wetlands are wooded and provide high value food and cover for woodcock, cottontail, and deer and are important nesting and feeding areas for wood and black ducks where the wetland borders open water. Other less abundant types of wetlands provide habitat for waterfowl, furbearers, and other wildlife.

Wetlands of particular importance to wildlife in the basin include the shallow water marshes north of Turner Pond in Walpole; the Beaver Brook and Massapoag Brook wetlands in Sharon; the Neponset River wetlands in Sharon, Canton, Norwood, Westwood, Dedham, Milton, and Boston; the wetland south of the town farm in Milton; the area on the northwest side of Ponkapog Pond in Randolph and Canton; the wetland along Meadow Brook in Walpole and Sharon; Cedar Swamp in Walpole; and the wetland complex south and east of Reservoir Pond in Canton. The salt marshes in the tidal area of the basin also provide important habitat for fish and wildlife.

Because wetlands make up a large percent of the undeveloped land in the watershed there is bound to be more pressure to develop these areas. Any plan to acquire wetlands in the Neponset Basin to provide natural valley storage areas for flood control would receive our support because such action would help maintain the wetlands as productive fish and wildlife habitat.

Fish and wildlife resources can be affected directly and/or indirectly, benefically and/or adversely, by proposals for wastewater management, water supply, and flood control. Wastewater management usually takes the form of sewage treatment plants, sewer lines and interceptors. However, it could also involve areawide planning for the treatment of non-point sources of pollution, such as agricultural wastes and storm-water runoff. In general, wastewater treatment projects are usually beneficial to fish and wildlife resources, by reducing and/or treating domestic and industrial discharges. Fish and wildlife resources may be adversely affected by these proposals, however, because of improper siting of treatment facilities in wetlands or productive shallow water habitats, by routing sewer lines through wetlands and water bodies without examining alternative routes or implementing proper construction procedures, or by treating pollutant discharges with excessively high levels of chlorine or other biotoxicants that can in themselves kill or harm aquatic life.

It is difficult to generalize about water supply projects, since they may take various forms. Water supply reservoirs can eliminate valuable stream and river fisheries, and inundate productive wildlife habitats. These adverse effects can be mitigated by the acquisition and management of additional fish and wildlife habitats. River diversions can be neutral in their effect, or they can be detrimental to fishery resources by withdrawing water needed to provide optimum flows for aquatic life. Ground water resources may be tapped for water supply, and again could be neutral or detrimental to fish and wildlife resources depending on the effects of withdrawal on surface water bodies and wetlands.

Flood control projects span the range from non-structural measures such as floodplain zoning and floodplain evaluation, to structural methods such as large dams and reservoirs. Effects on fish and wildlife resources depend on the type of project. Non-structural solutions have an indirect benefit in that no fish and wildlife habitat is lost, and acquisition of floodplain habitat or wetlands preserve natural resource habitat. Mitigating features can be incorporated into many projects, and acquisition and management of additional project land can become a part of large projects such as dams and reservoirs. The Fish and Wildlife Service normally encourages non-structural solutions, such as purchasing or obtaining easements of floodplain or wetlands. When structural solutions are necessary, we recommend the least damaging proposal that meets the project objective, and mitigating and/or compensating for any unavoidable habitat losses.

We will be pleased to continue working with you on this study as you focus in on specific problem areas and solutions.

Sincerely yours,

Gordon E. Beckett
Supervisor

AREA OF

CRITICAL ENVIRONMENTAL

CONCERN

APPENDIX E

NEPONSET RIVER BASIN

MASSACHUSETTS

TABLE OF CONTENTS

PREFACE

The Neponset Conservation Association completed a report in March 1981 for consideration by the Secretary of Environmental Affairs in his evaluation of a request for designation of portions of the Neponset River Basin as an Area of Critical Environmental Concern (ACEC).

This report is also for the purpose of aquainting the basin communities with the area's critical resources and the purpose and effects of such designation. It would review all development proposals that would impact on critical resources such as wetlands and groundwater sources.

The Neponset Conservation Association was established in 1965 for the purpose of land and water conservation in the Neponset River Watershed. The organization historically was comprised of representatives from Conservation Commissions of towns located in the area and still serves to represent all the communities of the watershed: Boston, Milton, Quincy, Dedham, Westwood. Dover, Walpole, Norwood, Canton, Randolph, Medfield, Stoughton, Sharon, and Foxborough.

It is in the interest of benefit to all these communities that the Neponset Conservation Association is nominating portions of the Neponset River Basin as an ACEC. The watershed represents a natural system of floodplains, wetlands, and surface and groundwater - a shared resource providing existing and potential water supply and protection against flood hazard. The proposed ACEC also includes natural areas which provide a variety of habitat for diverse species of wildlife and a unique opportunity for educational and recreational activities.

We would like to thank those who have contributed to this effort through their support and interest with a special acknowledgement to the contribution of the Army Corps of Engineers, the Executive Office of Environmental Affairs, and Coastal Zone Management.

ACEC DESIGNATION — What It Means

As part of a program to protect the valuable drinking water resources and significant wetlands and flood plains of the Neponset River Basin the Neponset Conservation Association is requesting designation of areas within the Neponset River Basin as an Area of Critical Environmental Concern (ACEC).

Our region's need for additional water supply of sufficient quality and quantity to meet growing demands is becoming increasingly evident. Secretary John Bewick of the Executive Office of Environmental Affairs, in an address delivered in June, 1980, described the Neponset watershed as an example of a critical aquifer which deserves protection recognizing future water needs.

The wetlands of the Neponset River Basin also deserve protection since they provide vital natural storage areas which act to reduce flood flows. Loss of such storage areas through development increases the potential for flood damage, and the risk to life and property.

Pressure to develop the land within the Neponset Basin is imminent and pervasive. Ideally, a balance can be achieved between growth and development and protection of the groundwater and wetlands. ACEC designation can contribute to this balance by focusing attention on the environmental sensitivity of the area.

Essentially, the means by which this special attention is achieved is through the process of environmental review under the Massachusetts Environmental Policy Act (MEPA). The effect of designation under MEPA regulations is two-fold: The first is a lowering of "thresholds" for review - projects normally excluded from MEPA review are not excluded in an ACEC. All projects of whatever magnitude which require state funding, permit(s), approval or other authorization are reviewed by the MEPA staff through the filing of an Environmental Notification Form. Such review applies to planning and policy development as well as actual construction projects. Although a full Environmental Impact Report is not necessarily required, projects within an ACEC would be subject to a higher standard of review thereby contributing to the protection of the area's environmental values.

The second effect of the designation is a directive to agencies of the Executive Office of Environmental Affairs, e.g. the Metropolitan District Commission, the Department of Environmental Management, the Department of Environmental Quality Engineering, the Massachusetts Water Resources Commission, that they take action to administer programs and/or revise regulations in order to protect the area and ensure that activities in or impacting the area are designed and carried out to minimize adverse environmental effects.

ACEC designation does not itself prohibit or restrict development, nor does it remove or interfere with local control or current zoning. Although there are some state permits which do not trigger the review process most projects of significant magnitude, including private development, are presently subject to MEPA review through state licensing. Thus, the net effect of the ACEC status is greater scrutiny of state projects in order to provide a greater degree of environmental protection.

NEPONSET RIVER BASIN
AREA OF CRITICAL ENVIRONMENTAL CONCERN

WETLAND AREA	LOCATION	DOWNSTREAM LIMIT/UPSTREAM LIMIT
1. Fowl Meadow	Boston, Milton Westwood, Dedham Norwood, Canton Sharon	Paul's Bridge/Route 1 (Neponset Main Stem)
2. Purgatory Brook	Norwood	Neponset River/Route 1
3. Cedar Swamp	Walpole	Neponset River/Winter Street
4. Massapoag Brook	Sharon	Washington St./Railroad Street
5. York & Pequid Brooks	Canton	Turnpike Street/Route 24
6. Massapoag Lake	Sharon	East Street/Wolomolopoag St.
7. Willet Pond	Walpole	Brook & Bullard Sts./Pettee Pond
8. Mine Brook	Walpole, Medfield Dover	Railroad Street/Powlissett St.
9. Neponset Reservoir	Foxborough	Crackrock Pond/Beach Street
10. Ponkapoag Pond	Canton	Washington Street/Route 28
11. Beaver Meadow Brook	Canton	Pleasant Street/Turnpike Street
12. Reservoir Pond	Canton	Pleasant Street/Turnpike Street
13. Beaver Brook	Sharon	Upland Road/Moose Hill Street
14. Pine Tree Brook Reservoir	Milton	Unquity Road/Randolph Avenue
15. Neponset River Floodplain		Connecting the Neponset Main Stem with Mine Brook and Cedar Swamp

RESOURCE FEATURES

To be eligible for designation, an ACEC must contain at least five resource features. Resource features of the Neponset River Basin include the river and its tributaries, flood plains, wetlands, meadows and swamps, reservoirs and ponds and the underlying aquifers.

The River

The Neponset River Basin is located south of the Boston Metropolitan area of eastern Massachusetts. Boston, Canton, Dedham, Foxborough, Medfield, Milton, Norwood, Randolph, Sharon, Stoughton, Westwood and Walpole are included within the basin which is bordered on the north and west by the Charles River Basin, on the south by the Taunton River Basin, and on the east by the South Shore coastal drainage system. The Neponset River drains an area of 115 square miles from its source at the Neponset Reservoir in Foxborough to its mouth at Dorchester Bay in Boston Harbor.

Major Tributaries

East Branch, also known as the Canton River, originates at Forge Pond in the center of the town of Canton. It has a total drainage area of about 31.2 square miles, characterized by small brooks and streams passing through local swampy areas. Key tributaries to the East Branch include Pequid, Massapoag, Beaver Meadow and Steep Hill Brooks.

Pequid Brook discharges into Reservoir Pond in Canton, draining 6.3 square miles. Upstream of the pond, the watershed is of typical wetland topography resulting in a very shallow stream slope and wide flood plains.

Massapoag Brook originates at Massapoag Lake in Sharon and passes through a large wetland along the Sharon - Canton border. The stream falls 160 feet in its 4.2-mile route and drains 7.1 square miles.

Beaver Meadow Brook in Canton falls 105 feet along its 3.2-mile course. A large wetland capable of significant storage borders the central portions of the stream.

Steep Hill Brook in Stoughton falls 180 feet in its 3.6-mile run, draining 6.1 square miles. An extensive wetland dominates the lower reach of the watershed.

Mother Brook is a continuous water canal connecting the Charles River with the Neponset River. Legislation adopted in 1831 provides that up to one third of the Charles River flow can be diverted through Mother Brook to the Neponset.

Other Tributaries to the Neponset River include: School Meadow, Mine, Diamond, Hawes, Traphole, Purgatory, Pecunit, Ponkapoag, Pine Tree and Unquity Brooks.

School Meadow Brook draining 3.2 square miles, rises in the wetlands bordering Walpole, Foxborough and Sharon, and travels northeasterly through a large wetland before meeting the Neponset River in Walpole. Mine Brook originates at Jewells Pond in Medfield. It levels out as it flows into Walpole through an extensive wetland of over 200 acres. Mine Brook joins the Neponset near Walpole center. Tubwreck Brook joins Mill Brook at the Dover-Medfield town line. Mill brook then flows southerly through a large wetland into Jewells Pond and Mine Brook.

Purgatory Brook originates in a large wetland abutting Dedham in Westwood. The stream enters the Fowl Meadow in Norwood. Flow through the Fowl Meadow is sluggish due to the characteristic wetland topography. Ponkapoag Brook originates at Ponkapoag Pond on the Canton - Randolph line and flows through a large wetland to the Neponset River adjacent to the Fowl Meadow. Pine Tree Brook begins in Quincy and flows into the Pine Tree Brook Reservoir in Milton. This brook drains the northern slopes of rhe Blue Hills range.

Wetlands

The Neponset River Basin contains a significant acreage of wetlands. The largest of these, the Fowl Meadow, extends from Milton and Boston along both banks of the Neponset River through Dedham, Westwood, Norwood, Canton and Sharon and covers nearly 3,100 acres, including Purgatory Brook. A major portion of the wetland is located within the 50-foot contour of the Neponset flood plain. The second largest wetland of approximately 1,030 acres is the Cedar Swamp, part of the River's source in walpole.

Ponds

There are seven major ponds related to the River: the Neponset Reservoir at the River's source in Foxborough, Bird and Willet Ponds in Walpole, Massapoag Lake in Sharon, Reservoir Pond in Canton, Ponkapoag Pond in Canton and Randolph, and Pine Tree Brook Reservoir in Milton.

Aquifers

Aquifers of glacial stratified drift, porous deposits of sand and gravel, overlie the bedrock of about half of the watershed. In some parts of the Neponset Valley, these deposits are more than 150 feet thick. The main stem of the Neponset aquifer system stores an estimated 95 billion gallons of water.

CRITERIA FOR DESIGNATION

In making the determination as to whether an area merits designation as an Area of Critical Environmental Concern (ACEC), the Secretary of Environmental Affairs considers certain criteria to evaluate environmental sensitivity and significance.

The purpose and intent of ACEC designation is to provide a higher level of environmental review of proposed development. The following paragraphs in this appendix describe the natural characteristics and resource values of the proposed Neponset River Basin ACEC and the serious, often irreversible effects indiscriminate development has on them.

Threat to the Resource

The wetlands of the Neponset ACEC have intrinsic values such as the ability to store flood water and to improve water quality. For the most part the aquifers of the proposed ACEC are located under wetlands, which, along with other surface water bodies such as streams and ponds are important parts of a natural system having the potential of providing hugh quantities of potable water. The loss of wetlands poses a serious threat to the resource values of the Neponset River Basin.

The wetlands of the Neponset River Basin are increasingly vulnerable to development largely because of their desirable location. The existing transportation network, the level of development in the general area and the scarcity of land make wetlands attractive sites for development. Although the site development costs in wetlands are high, the initial land purchase costs are low as compared to uplands. Increased demands on all available land, including proposals involving the draining and filling of wetlands, are already occurring at an alarming rate. Growth necessitates the improvement and expansion of public services such as roads, sewer, and water systems. This inevitably affects wetlands with potentially significant environmental impact. The contamination of water supplies by road salt and spilled hazardous waste materials are present concerns which illustrate this potential impact.

Threat to the Public Health, Safety and Welfare

A primary concern in evaluating the need for protective measures for the Neponset River Basin ACEC is the two-fold threat to the public health, safety and welfare posed by unchecked development. Namely, the deleterious effects on groundwater which result in loss of valuable present and future water supplies through diminution of quantity and lowering of quality and the loss of flood storage areas, increasing the potential for flood damage and the risk to life and property.

Groundwater

A percentage of the precipitation falling on the Neponset River Basin finds its way to underground deposits of coarse sand and gravel. In these porous glacial deposits, or aquifers, water moves freely and is stored. According to a hydrologic study done by Brackley, Fleck and Meyer for the Massachusetts Water Resources Commission in 1973, aquifers suitable for the development of potentially large capacity wells are located under much of the Neponset River Basin ACEC. The main stem of the Neponset aquifer system is reported to be capable of yielding 80 million gallons per day (mgd), of which 55 mgd may be considered as "recoverable water."

Presently, most of the communities located in the Neponset River Basin depend at least in part on this aquifer system for their water supply. In addition to potable and household use, important use of this water is made in commercial establishments, industrial processes and firefighting. An estimated average total of 11.8 mgd is currently pumped from aquifers within the proposed ACEC.

Reliance on local supplies can be expected to become increasingly necessary as demand for water becomes greater because of growth and increased per capita use. The Metropolitan District Commission (MDC) Water District which currently serves some of these communities is exceeding its safe yield limit of withdrawal from its Quabbin Reservoir by an estimated 18-20 mgd. Therefore, the MDC cannot be expected to provide additional water to communities within the Water District's area of entitlement, nor extend service to outlying communities.

It was projected in the Massachusetts Water Supply Policy Study by the Executive Office of Environmental Affairs in 1977 that no town in the Neponset River Basin will have sufficient water system capacity to meet its summer needs by 1990. Realistically, communities can anticipate the need to maintain the integrity of existing water supplies while identifying and protecting potential additonal sources. Favorable locations for surface storage reservoirs are not available in the watershed. The Neponset aquifer represents a significant underground reservoir with a potential for contributing to future water supplies in the immediate region, while contributing to the stability of water supply for other areas of the state by decreasing dependence on the MDC system.

Contamination of existing supplies has a dramatic effect on total available water for consumption. The chemical quality of the ground water has been deteriorating during recent years. In fact, wells totalling 7.0 mgd are currently out of service in the watershed. The major quality problems in most streams and in much of the ground water are concentrations of iron and manganese, color, chloride, organics and toxic metals. The increases of dissolved solids reflect the increased use of road salt and increased loads from dumps, septic systems and other sources.

Canton lost one municipsl and one private well in 1979 to Trichloroethylene contamination. This municipal well of 500,000 gallons per day had provided 12 percent of Canton's total supply. Two wells of the Dedham Water Co. closed for the same reason. They had provided 2.5 mgd or 30 percent of the total supply this company had available for its service population of 43,500. In the abandoned Ellis wellfield in Norwood extremely high levels of Trichloroethylene were found - up to 150,000 times the recommended safe levels. With regard to the Ellis Wellfield supply, a report completed by the Department of Environmental Quality Engineering in September 1979 had this conclusion: "The probable impact of this contamination incident is the permanent loss of an otherwise viable water supply source of substantial yield in an area experiencing increased demands on limited resources." The report states further that to determine the source and extent of contamination is "very expensive" and that the "state lacks the staff and budget to accomplish such a program."

In a report done on abandoned or reserve water supplies in the MDC service area by the Army Corps of Engineers, the high cost of treating contaminated groundwater supplies is convincingly illustrated. Springdale supply in Canton contaminated by poor quality surface water from road runoff and residential development would require $900,000 for treatment of .70 mgd to rid the water of its defects including high sodium levels. The Ellis Station in Norwood contaminated by runoff from Route 1 and estensive residential, industrial and commercial development would require treatment

including activated charcoal to rid its supply of pollutants which include Trichloroethylene and Trichloroethane. The cost for such treatment is estimated at $2,165,000 for a 2.5 mgd plant. The Buckmaster Pond Supply in Norwood also contaminated with Trichloroethylene and Trichloroethane, considered to be the result of residential development around the pond, would require $870,000 for a plant to treat itd 1.5 mgd*# demand.

The quantity of recoverable water is also important. The amount of groundwater available is directly related to the amount of recharge occurring in the watershed. Increased amounts of impervious surfaces which accompany development alter natural drainage patterns, increase the rate of runoff, reducing the amount of water which recharges the aquifers below. Placing of pavement and structures results in an essentially permanent loss of areas of infiltration. A balance needs to be achieved between maintaining the recharge characteristics of natural areas and accomodating development.

Flood Storage

Nearly 13 percent of the Neponset Basin is comprised of wetlands which provide natural flood storage. Nearly all the land in the proposed ACEC is classified or zoned as flood plain. Wetlands reduce flood damage potential by retaining flood water and releasing it over an extended period of time, lowering peak runoff levels.

The effectiveness of wetlands in controlling flood flows can be seriously diminished by development. Increasing the amount of impervious surface accelerates the amount of runoff with the result that life and property in the area are under increased threat of injury or damage because of higher flood levels. Preliminary investigations done in 1971 by a consultant for the Massachusetts Water Resources Commission indicate that a 50 percent loss of this valuable storage could result in flood stages three feet higher than normal. Even a 10 percent loss of wetland storage could raise flood stages by a half foot. Because of the flat topography of the Neponset River Basin, any rise in flood level impacts a wide area. Areas not previously flood-prone will suffer flood losses and existing flood-prone development will realize more damage.

The benefit derived from the protection of wetlands as flood storage areas is immeasurable in terms of preservation of life and dramatic economically in terms of the protection of property. According to the Army Corps of Engineers, the storm of March 1968 resulted in $1.5 million in damage in the basin. Today that amount would be more than tripled! Monetary damage suffered from Hurricane Diane in 1955 was approximately $6 million and would translate into 30 million plus today!

* Cost estimates by Fay, Spofford and Thorndike, Inc.
# In addition to capital costs, the extra cost of MDC water to replace water lost through pollution is nearly $100/million gallons or $700.00 per day for the polluted wells in Canton, Norwood and Westwood.

Magnitude and Irreversibility of Impact

The critical aspects of the impact of development in the Neponset River Basin proposed ACEC as indicated above are: the reduction or loss of potentially abundant water of good quality and the loss of the value of wetlands for effective flood control through natural storage. The magnitude of the effect of development if it results in a lack of safe drinking water cannot be overstated. From an economic point of view, it is far wiser to protect potential water sources than to incur the tremendous expense of purifying polluted supplies. Decontamination may be technologically possible but so economically impractical and infeasible that the impact of contamination might be considered irreversible. Likewise, the impact of severe flood damage can be drastic in terms of property loss and irreversible in terms of loss of life.

Further, there is the impact that development can have on the balance of the ecosystem in the watershed by altering characteristics of the Neponset river and its adjacent lands. The natural holding capacity, the watershed's ability to hold water and release it gradually, has diminished over the years with progressive development. The flow of the river has become less uniform, with high spring and low summer flows.

The wetlands and marshes of the Neponset River Basin are hydraulically connected to the area's water table. In the summer, marsh and swamp areas dry out as a result of the lower water table. Such changes result in altered habitats. A rise in the water table will suffocate many marsh plants and a fall in the water table deprives marsh dwelling wildlife of the conditions it needs to survive. The Fowl Meadow, rich in wildlife and vegetation is particularly susceptible to such changes in the water table.

Further development affecting the storage capacity of the basin will magnify this condition. Without careful management of the watershed's wetlands to insure no further decrease in storage capacity the study area's retention capabilities could permanently be altered.

Additionally, the value that wetlands provide in pollution prevention is decreased as wetlands are drained or filled for development. Recent studies indicate that certain wetland plants and soils can reduce pollution through a process of natural absorption of pollutants such as phosphates and nitrates introduced in runoff.

Natural Characteristics - Uniqueness of Area

The Neponset River Basin is inhabited by diverse species of fish and wildlife (Table E-1) in a variety of habitats. Approximately 60 percent of the study area is comprised of forest (including wooded wetlands),

wetlands, agricultural and open space land, and water. This varied habitat is unique considering its proximity to the highly developed area of Metropolitan Boston.

TABLE E-1

FISH AND WILDLIFE SPECIES
NEPONSET RIVER BASIN

COMMON FISH SPECIES

pumpkinseed	largemouth bass
yellow perch	white perch
brown bullhead	black crappie
chain pickerel	white sucker
golden shiner	smallmouth bass
blue gill	

WILDLIFE SPECIES

ruffed grouse	muskrat
gray squirrel	mink
cottontail	skunk
woodcock	fox
ringnecked pheasant	racoon
varies species of waterfowl	beaver

Wetlands are particularly important as wildlife habitat. Their natural characteristics support abundant and varied species. The number and variety would be diminished if the wetlands, which presently make up a significant portion of the undeveloped land in the watershed, were developed.

There are several species found in the Neponset River Basin which are considered rare or endangered according to state and federal standards. Included are the migratory Bald Eagle and Peregrin Falcon, and the American Bittern, Black Poll Warbler, Great Blue Heron, Osprey, Parula Warbler, Swainson's Thrush, Blanding's Turtle and Blue-Spotted Salamander.

The MDC's 500-acre Neponset River Reservation offers a valuable educational and recreational resource. The Fowl Meadow, one of the largest wetlands in the Boston area, provides a great variety of vegetation and an outstanding habitat for wildlife. In its existing condition, it represents an asset with considerable potential for wider use by the public for their enjoyment and enrichment. The Metropolitan Area Planning Council's Open Space and Recreation Program for Metropolitan Boston stated first priority action is "controlled open space development to expand its use."

The Neponset River Basin is also potentially rich in archaeological history - river banks were common sites for prehistoric settlement. The Green Hill Archaeological Site located in the Neponset River Reservation was recently listed on the National Register of Historic Places as one of the oldest Indian settlements of the Commonwealth dating back approximately 7000 years.

Also of historical significance is Paul's Bridge in Milton at the outlet of the Fowl Meadow. It was first built 300 years ago and is listed on the National Register of Historic Places.

The river played an important role in the establishment of the communities in the region. Many of the towns located in the basin have industrial origins. Early industry relied on water for power and processing. The Fowl Meadow once was used as agricultural land because of its marsh grasses. These were harvested in a time when domestic animals such as horses were essential to man's existence.

Economic Benefits of Regional Management of the Resources of the Neponset River Basin

The most abundant and generally available source of water for the communities located in the Neponset River Basin is groundwater. Because of its "invisible" nature and widespread location, proper care and protection of the underground aquifer is much more difficult than for a surface reservoir. Management of the resource can be ineffective when each community's control is limited by town boundaries. When a number of towns are sharing an aquifer for independent supplies, each is vulnerable to the possibility of pollution from areas over which it has no control.

Wetlands over these groundwater supplies can be very attractive for industrial and other development because of low purchase costs and proximity to Routes 128 and I-95, the railroad system and the Metropolitan Boston area which is very accessible in terms of commuting time. In the long term, however, it is of significantly greater economic benefit to protect the quantity and quality of groundwater supply than to indiscriminately develop for short term economic reasons.

The costs involved in detecting the sources and extent of contamination of water supplies and the building, maintenance and operation of treatment plants can be extremely high. This is born out in the case of the Norwood Ellis Wellfield where the captal outlay alone would be $2,165,000!

No town in the watershed will have sufficient water system capacity to meet its summer needs by 1990. In fact, some towns in this area are not meeting their summer needs adequately now. As a result of the loss to contamination of two Dedham Water Co. wells, the towns of Dedham and Westwood imposed bans on watering lawns, washing cars and other unnecessary uses of water.

Towns now using MDC water or hoping to use it in the future must consider that the MDC supply is already pressed and may not always be adequate for the urban and suburban needs of the metropolitan Boston area. It may be some time before solutions to the present MDC water supply shortfall are realized. Dependence on local supplies will increase as a result.

For these reasons groundwater management in the Neponset River Basin needs to be planned on a regional basis. The problem is illustrated in numerous water supply studies done for area communities including Canton, Walpole, Norwood and Stoughton which demonstrate the need for planning and conclude that intertown cooperation is necessary. For the town of Walpole, for example, consultants Weston and Sampson listed in their 1980 report a recommendation to "Contact surrounding towns in the watershed...ask them to join you in your effort to protect the watershed."

The ACEC designation can contribute to the regional policy and planning for such crucial responsibilities as meeting our future water needs. The additional benefit is protection against flood hazard and a guarantee for the preservation of natural areas which contribute to the quality of life.

REFERENCES

1. Neponset River Basin Flood Plain Management Study. Reconnaissance Report, Department of the Army, New England Division, Corps of Engineers, November 1979.

2. Hydrologic Data of the Neponset and Weymouth River Basins, Massachusetts. Department of the Interior, Geological survey, 1973.

3. Chemical Contamination. Water Quality Task Force of Special Legislative Commission on Water Supply, Massachusetts Department of Environmental Quality Engineering and U.S. Environmental Protection Agency, September, 1979.

4. Abandoned or Reserve Water Supplies, Metropolitan District Commission Service Area. Coffin and Richardson, Inc. for Department of the Army, New England Division, Corps of Engineers, February, 1980.

5. Fowl Meadow Marsh, Natural Resources Inventory. Boston Transportation Planning Review, Jason M. Cortell Associates, 1971.

6. Massachusetts Water Supply Policy Study. Executive Office of Environmental Affairs, January, 1977.

7. Neponset River Basin Flood Plain and Wetland Encroachment Study. Massachusetts Water Resources Commission, 1971.

8. Open Space and Recreation Program for Metropolitan Boston. Metropolitan Area Planning Council, Vol. 3, April, 1969.

9. Guide to Understanding and Administering the Wetlands Protection Act. Massachusetts Audubon Society, June, 1977.

10. Assessment and Recommendations for Community Water Resource Planning. Skidmore, Owens and Merrill, for the town of Stoughton, December 1980.

11. Report on Water System Master Plan. Weston and Sampson, for the town of Walpole, January, 1980.

12. Report on Groundwater Supply Facilities. Fay, Spofford and Thorndike, Inc., for the town of Norwood, March 1980.

13. Report Relative to Water System Improvements. Whitman and Howard, for the town of Canton, January 1980.

APPENDIX F

FLOOD DAMAGE PREVENTION MEASURES

FLOOD DAMAGE PREVENTION MEASURES

This appendix provides a more detailed description of alternative flood damage prevention measures discussed earlier in Section III, Preliminary Plan Formulation. The chart below summarizes alternatives that modify the extent of flooding and those that reduce flood damage vulnerability.

Modify Extent	Reduce Vulnerability
Reservoirs	Floodproofing
Levees	Flood Warning and Evacuation
Walls	Flood Plain Regulations
	Flood Insurance
	Acquisition of Flood Plain Land

A. Modify Extent.

1. Reservoirs - The function of a flood control reservoir is to store a portion of the flood flow in such a way as to minimize the flood peak at the point to be protected. In an ideal case, the reservoir is situated immediately upstream from the protected area and is operated to "cut-off" the flood peak. Water is released according to the safe capacity downstream, and excess is stored to be released later.

A single reservoir cannot give equal protection to a number of damage sites located at differing distances downstream. Often several small reservoirs are indicated in preference to a single large storage area.

The wetlands in the Neponset River Basin act as natural valley storage areas providing this same flood control function as manmade reservoirs. The scattered locations of these areas throughout the watershed protect potential damage sites downstream.

2. Levees and Walls - When depths of flooding are not deep (less than 5 feet), individual or groups of structures can be protected by levees (small earth dikes) and/or walls.

Dikes are usually constructed with an impervious inner core to prevent water seepage. Slope protection can be combined with a levee if erosion is a problem. Levees can be designed to be compatible with many landscapes, and at the same time serve to exclude floodwaters.

Walls may be of brick, stone, concrete or other material designed to resist the physical forces associated with flooding. In urban areas, where space is limited, walls running along property lines may be low (3 feet) so as not to hide store fronts, or high (5 feet) to create patio or garden areas for homes. A wall may be attached to a structure, for example, by running along a porch, or detached and located at the property line like a fence.

Where access openings are necessary, provisions must be made to close them during floods. This generally means providing a flood gate which can either be stored at the opening and installed when needed, or constructed with hinges or rollers for automatic or semiautomatic closure.

During flood conditions it is possible for precipitation, seepage and runoff from roof drains to cause water to accumulate inside the wall or levee and cause water damage to the property being protected. This problem can be reduced by providing means to remove the water. Generally this involves a low-lying sump area to collect the drainage and a pump to remove it. The pump discharge level should be located above the design flood stage.

B. Reduce Vulnerability

1. Floodproofing

c. Closures for Openings - Structures whose exteriors are generally impermeable to water can be designed to keep floodwater out by installing watertight closures to openings such as doorways and windows. While some seepage will probably always occur it can be reduced by applying sealants to walls and floors, and providing floor drains where practical. Closures may be temporary or permanent. Temporary closures are installed only during flood threat; and, therefore, need warning time before installation.

To prevent seepage around exterior doors, installation of some form of floodproofing is required. One type is flood shields. Shields are normally fabricated of aluminum, steel, or wood and made to the height and width desired. In commercial/industrial structures they may be permanently installed on hinges or rollers for swinging or sliding into place or, more often and particularly for residential structures, they may be stored nearby for installation during a flood. Doorways not needed may be permanently closed in with masonry or other relatively impermeable materials.

Normal window glass will take little water pressure and is especially vulnerable to breakage by floating debris. Flood shields are also commonly used to protect windows. They may also be permanently installed on hinges or rollers at the window openings, or stored elsewhere and installed temporarily during floods. Like doors, windows not needed can be permanently closed.

Other measures, such as waterproofing sealants, are sometimes applied to generally impermeable floors and walls to further reduce seepage. Sewer lines and other plumbing facilities can be floodproofed by installing non-backflow and gate valves, and floor drains equipped with non-backflow prevention features.

Some water may enter a structure even though it is made generally watertight, so sump pumps should be included to remove any seepage that might occur. The pump outlet should be installed above the expected level of flooding.

Most structues, whether residential, commercial or industrial, are not designed to withstand water pressure on the exterior walls. Therefore, when discussing physical feasibility the principal considerations are that (1) the exterior walls are impermeable or can be made so, (2) all openings below the flood level can be closed, and (3) the structure can withstand anticipated water pressures, including buoyancy.

Structures with exterior walls constructed of masonry materials are relatively impermeable, and can be made more so by sealing exterior surfaces. The only adjustments necessary are to minimize seepage through walls and floors with waterproofing materials, and to close doorways, windows and plumbing lines. Structures with sidings of generally permeable materials are difficult to floodproof to the extent of keeping water out. Even for those constructed of relatively impermeable materials, the conditions of the structure and the number, location, and size of openings influence the feasibility of providing closures.

When water is prevented from entering a structure, the walls become subject to forces which may cause failure. The floors are subject to uplift forces which may cause buckling or flotation. It is particularly difficult to analyze the capability of existing structures to resist these forces because of the general lack of knowledge about workmanship and materials used during construction and about their present condition.

Advantages

- Floodproofing may be done on a selective basis to only those openings through which water enters and only to the height desired.

- Easy and quick to implement.

Disadvantages

- Applicable only to structures with brick or masonry type walls without basements, which can structurally withstand the forces associated with flood depths.

- May not be put in place at night or during absences.

- May create a false sense of security and induce people to stay in the structure longer than they should.

b. Raising Existing Structures - Existing structures in flood hazard areas can often be raised in place to a higher elevation to reduce their vulnerability to flood damage.

Technology exists to raise almost any structure. From a practical viewpoint, raising-in-place is most applicable to structures which can be raised by low-cost conventional means. Generally, this means structures that (1) are accessible below the first-floor; (2) are light enough to be raised with conventional house-moving equipment; and (3) do not need to be partitioned prior to raising. Wood-frame residential and light commercial structures with first floors above grade are particularly suited for raising. Structures with concrete floor slabs or common walls are feasible to raise only with special equipment - involving additional expense.

Advantages

- Damage is reduced for floods below the raised first floor elevation.

- Particularly applicable to single and two-story frame structures on raised foundations.

- Structures can be raised to heights up to 9 feet.

- The means of raising a structure are well known and contractors should be readily available.

- Raising-in-place allows for continued use at the existing location.

Disadvantages

- Residual damages exist when floods exceed the raised first floor elevation.

- Not generally feasible for structure with slab-on-grade.

- Landscaping and terracing may be necessary if the height raised is extensive.

c. Rearranging or Protecting Damageable Property - Within an existing structure, damageable property can often be placed in a less vulnerable location or protected in-place. It is something every property owner can do to one degree or another.

The degree to which property can be rearranged and protected is site specific. It depends on the flood hazard, principally depth and frequency of flooding; the damageable property - its type, value, location and moveability; the availabilty and adaptability of adjacent, less flood-prone locations; and whether the rearrangement allows the use of protective types of measures where appliances, utilities, equipment and goods can be raised in-place and protected. Where the hazard is more severe and inundation is to greater depths, property will need to be relocated to prevent damage.

Residual damage to both structures and contents will remain even when property is rearranged or protected. For these reasons, protection of property seems to be more seriously considered when other measures are either not physically or economically feasible, or the depth of flooding is relatively shallow.

Advantages

- Almost any residential, commercial or industrial property owner can do this to one degree or another.

- It can be done on a per item basis, thus reducing the cost and allowing selective protection of high value goods.

- A structure can continue to be used at its existing site.

Disadvantages

- Damage can be reduced only on those items which can be relocated or protected.

- There remains a potential residual damage to the structure and contents not relocated or protected.

d. Relocation of Existing Structures and/or Contents - There are basically two options for removing property to a location outside the flood hazard area. One is to remove both structure and contents to a flood-free site; the second is to remove only the contents to a structure located outside of the flood hazard area, and demolish or reuse the structure at the existing site.

If the structure is reused, it should be for something with contents that are not readily damageable. Other possibilities include removing part of the contents, relocating one of a group of structures, or modifying an existing structure to accommodate a new use. In each case the purpose is to remove damageable property from the hazard area, yet take advantage of opportunities for using the existing property in ways compatible with the flood hazard.

While the experience and equipment for moving many different types of structures exist, there is a practical limit on the size and type that is economically feasible to move. Even the most readily relocatable structures are costly to remove.

One or two-story residential and light commercial structures of wood frame on raised foundations or basements are usually easy to move because of the structure weight and access to the first floor joists. Structures of brick, concrete or masonry can also be moved; however, additional precautions must be taken to prevent excessive cracking. Most commercial/industrial buildings are not feasible to move because of their size and type of construction. Rather than relocate the structure, it is usually more practicable to remove the contents and find a new use for it. Similar action is sometimes taken when the damage potential to contents is high, as with valuable merchandise or machinery.

The advantages of removing contents include elimination of flood damage to the existing contents; and if the structure is demolished, structural damage is also eliminated. Disadvantages are damage to the structure and site if the structure is reused, and costs to remove contents and demolish the structure are high.

Advantates of relocation are that flood damage is eliminated completely and maintenance of the flood plain land is reduced. Removal also allows land use adjustments that may be beneficial to the community. Disadvantages usually associated with relocation are its cost and loss of any advantage of the flood plain site.

2. Flood Warning and Evacuation - Flood forecasts, warning and evacuation is a stragety to reduce flood losses by charting out a plan of action to respond to a flood threat. The strategy includes:

- A system for early recognition and evaluation of potential floods.
- Procedures for issuance and dissemination of a flood warning.
- Arrangements for temporary evacuation of people and property.
- Provisions for installation of temporary protective measures.
- A means for maintain vital services.
- A plan for postflood reoccupation and economic recovery of the flooded area.

Flood warning is the critical link between forecasts and response. An effective warning process will communicate the current and projected flood threat, reach all persons affected, account for the activities of the community at the time of the threat (day, night, weekday, weekend) and motivate persons to action. The decision to warn must be made by responsible agencies and officials in a competent manner to maintain credibility of future warnings.

An effective warning needs to be followed by an effective response. This means prompt and orderly evacuation of people and property. Actions that can facilitate this include:

- Establishment of rescue, medical and fire squads.

- Identification of rescue and emergency equipment.

- Identification of priorities for evacuation.

- Surveillance of evacuation to insure safety and protect property.

In addition, a forecast, warning and evacuation strategy will include telephone, energy (gas and electric), sewage, water, traffic control and hospitals as well as police and fire services. Postflood reoccupation and recovery includes:

- Re-establishment of conditions that will not endanger public health; such as, disease and insect control, safe drinking water, safe sewage disposal, medical supplies.
- Return of other vital services.
- Removal of sediment, debris, flood fighting equipment and materials.
- Repair of damaged structures.
- Establishment of disaster assistance centers for financial and other assistance.

Factors that determine the physical feasibility of forecast, warning and evacuation measures are somewhat different from those that determine the physical feasibility of many other nonstructural measures, whose feasibility is directly related to the type structure and depth of flooding. Forecast, warning and evacuation feasibility is more dependent upon hydrologic, social and institutional factors. One system of forcast, warning and evacuation may be appropriate for one community, but not for another because an infrastructure of community and insitutional arrangements are necessary to effectively use hydrologic information. The degree to which this infrastructure is created influences the effectiveness of different warning and evacuation measures.

Advantages

- Preparedness planning is almost always economically feasible and desirable. Something can usually be done even in areas where other flood loss reduction measures are implemented.

- Accurate forecasts and warnings may permit sufficient time to implement temporary protective measures to significantly reduce flood damage.

Disadvantages

- The effectiveness of the warning system and response of the community cannot be accurately predetermined, consequently, neither can potential flood damage reduction.

- Requires a continuous awareness and information program, maintenance of equipment, etc.

- Effectiveness of preparedness plans tends to diminish with increasing time between floods.

3. Flood Plain Regulations.

a. Zoning - Ordinances on the use of structures and land, the height and bulk of structures, and the size of lots and density of use is usually based upon some broad land use plans to guide the growth of the community. The characteristic features of zoning that distinguish it from other police power controls is that it can differ from district to district in the city. For this reason it can be used to set special standards for land use in flood hazard areas.

The flood plain regulations contained in a zoning ordinance consist of two parts: (1) a written text which sets forth the regulations which apply to each district together with administrative provisions; and (2) a map delineating the boundaries of the various use districts. The important aspects of zoning is that it can be used to regulate what uses may be conducted in flood hazard areas, where specific uses may be conducted, and how uses are to be constructed or carried out. Zoning can also be used to establish minimum elevation or floodproofing requirements for the uses.

b. Subdivision Regulations - These guide the division of large parcels of land into smaller lots for the purpose of sale for building development. Subdivision regulations with special reference to flood hazards often (1) require installation of adequate drainage facilities, (2) require filling of a portion of each lot to provide a safe building site at elevation above selected flood heights, and (3) require the placement of streets and public utilities above a selected flood protection elevation.

The regulations require that the subdivider prepare a plat - a detailed map of the proposed subdivision land. The plat must be approved by the local regulatory agency, usually the planning board, before lots are sold. The agency checks the plat for compliance with subdivision regulations, the local master plan, the zoning ordinaces, and other regulations. A proposed subdivision plan is typically reviewed to determine the adequacy of the street system: size of blocks and lots, provisions for parks and open spaces, sufficiency of water and sewage systems, adequacy of drainage, safety from flood or other hazards, and additional specifications set forth in the ordinance.

c. Building Codes - These neither regulate where development takes place nor the type of development, but rather specify building design and materials. Building codes can reduce flood damages to structures by setting specifications to: (1) prevent flotation of buildings by requiring proper anchorage, (2) establish minimum floor level elevations consistent with flood potential, (3) restrict use of materials which deteriorate when exposed to water, and (4) require structural design consistent with water pressure and flood velocities.

General flood-proofing requirements are sometimes placed in flood plain zoning ordinances rather than building codes in the form of general performances standards which give the developer an option of elevating his structure to a safe height. Housing codes, like building codes, set minimum standards for construction but also set minimum standards for maintenance of structures. These can be used to require repair of flood damaged structures to assure the safety of occupants and prevent blighting.

d. Feasibility - Zoning, subdivision regulations, and building and housing codes are generally feasible for any flood plain land, whether the land is occupied by residential, commercial or industrial type structures or by nonstructures such as golf courses and playgrounds. While there are no general limitations, a regulatory program is developed and administered for a specific piece of land; thus, when developing such regulations at the local level some very real restrictions may develop. Several considerations are discussed below:

- The 14th Amendment of the United States Constitution require that police power regulations be reasonable, related to regulatory objectives and afford equal treatment to similarly situated individuals.

- Flood plain regulations are subject to the same general legal requirements as other land use controls.

- The power to regulate flood plain land uses must be found in the general or special language of enabling statutes.

- Courts generally determine only the specific constitutionality of enforcing land use regulations against a complaining landowner and not the general constitutionality of regulations applied to all landowners.

- Widespread judicial support can be found for regulations requiring that those who use lands be responsible for actions which substantially harm public or private interests.

- Flood plain regulations must be based upon sound data to meet constitutional requirements.

- Flood plain regulations often provide for general rules that apply to all uses and additional case-by-case evaluation of certain special uses.

- Whenever possible, flood plain regulations should be part of comprehensive water and related land use management programs.

- Regulations must balance private and public rights to withstand attacks that the regulations "take" private property without payment of just compensation.

In addition to the above, regulations must be flexible and fair. Procedures for amendments and variances are necessary and can be provided by establishing criteria for special use permits. Also, regulations must be designed to prevent public harm rather than service public benefits.

Costs associated with preparing, adopting and administering zoning ordinances, subdivision regulations, and building and housing codes include:

- Cost of obtaining basic engineering data.
- Costs to draft and adopt a regulation.
- Costs to administer a regulation.
- Possible loss of tax revenue.

Model ordinances are readily available to guide preparation of specific regulations. Also, guidance and assistance is available from Federal agencies at no cost. For these reasons the cost of actually drafting the regulations is sometimes relatively low and handles as a normal staff function. Public and other meetings must be held for adoption and these costs must also be included.

Costs to administer a regulation can be major or minor depending upon the "interest." Flood plain land not subject to the development pressures of urban areas would probably have a negligible administration cost. As development pressure increases administration is likely to be more costly and time consuming as "interest" increases and individuals and groups request and appear for variances.

Another possible cost is loss of tax revenue. This loss is measured as the difference in the tax revenue with and without the regulation. In most situations this loss will be small or insignificant because development locating elsewhere in the area will transfer the higher evaluations with no loss of revenue to the municipality. In some situations the flood plain may be the last area of land. Utilizing it for a higher taxable use will increase tax revenues, and regulating it will cause a loss of such revenues. Estimates must be made on a site-by-site basis.

Advantages

- An effective means of bringing about the proper use of flood plain lands. Economic, environmental, and social values can be integrated with the recognized flood hazard.

- Helps to keep flood damage from increasing. By addressing non-conforming uses they can be helpful in achieving the necessary land use adjustments to mitigate existing flood problems.

- Can be effective over time on existing improper development or additions and modifications to existing property.

Disadvantages

- Not effective in reducing flood damage to existing structures.

- Subject to variance or amendment by local government bodies which can reduce effectiveness considerably.

- Tend to treat all flood plain property equally when in fact various economic factors may make one type of development more appropriate for one portion of the flood plain and another type more appropriate elsewhere.

4. Flood Insurance - This is not really a flood damage prevention measure as it does not reduce damages; rather it provides protection from financial loss suffered from a flood. The National Flood Insurance Program was created by Congress in an attempt to reduce, through more careful planning, annual flood losses and to make flood insurance protection available to property owners. Prior to this program, the response to flood disaster was limited to the building of flood control works and providing disaster relief to flood victims. Insurance companies would not sell flood coverage to property owners, and new construction would often overlook new flood protection needs.

Flood insurance is an option for all owners of existing buildings in a community identified as flood-prone, yet it is compulsory for all buyers of existing or new buildings in the Federal Emergency Management Agency (FEMA) designated 100-year flood plain where Federally insured mortgages or mortgages through Federally connected banks are involved.

Qualifying for the National Flood Insurance Program involves a community in two separate phases - the emergency phase and the regular phase. The Emergency phase limits the amount of insurance available to local property owners. In this phase, FEMA provides the community with a Flood Hazard Boundary Map that outlines the flood-prone areas within the community. Owners of all structures, regardless of their flood risk, are charged subsidized rates during this phase of the program. Available coverage and rates are shown on the following chart.

FLOOD INSURANCE

	Emergency Program		Regular Program			
	Total Amount Available First Layer *	Subsidized Rate of $100 of Coverage	Second Layer	Acturial Rate Per $100 Coverage Based on Risk	Total Amt. Available 1st & 2nd Layers**	Max. Required
Single Family Residential	$ 35,000	$ .40	$150,000	Rate Varies With Risk	$185,000	$ 70,000
Other Residential	$100,000	$ .40	$150,000	Rate Varies With Risk	$250,000	$200,000
Contents, Residential	$ 12,000	$ .50	$ 50,000	Rate Varies With Risk	$ 60,000	$ 20,000
Small Business	$100,000	$ .50	$150,000	Rate Varies With Risk	$250,000	$200,000
Contents, Small Business	$100,000	$1.00	$200,000	Rate Varies With Risk	$300,000	$200,000
Other Nonresidential	$100,000	$ .50	$100,000	Rate Varies With Risk	$200,000	$200,000
Contents, Other Nonresidential	$100,000	$1.00	$100,000	Rate Varies With Risk	$200,000	$200,000

(Limits required under Section 102(a)(b) of Act of 1973)

NOTES:

* Only the first layer of coverage is available under the Emergency Program. Slightly higher limits of coverage are available for purchase under the Emergency Program in Hawaii, Alaska, the U.S. Virgin Islands and Guam.

** a. Full coverage is available under the Regular Program for all structures in the community.
b. New construction and substantial improvements are charged actuarial rates for all coverage.
c. All existing structures are charged actuarial rates for the second layer of coverage and property owners have the option of paying either the subsidized or actuarial rate for the first layer, whichever is lower.

In order to qualify for the Emergency Program a community must adopt preliminary flood plain management measures including floodproofing for all proposed construction or other development. They must be reviewed to assure that sites are reasonably free from flooding. All structures in flood-prone areas must be properly anchored and made of materials that will minimize flood damages; new subdivisions must have adequate drainage; and new or replacement utilitiy systems must be located to prevent flood losses.

The full amount of flood insurance is available under the Regular Program. The amounts charged for insurance of new construction vary in accordance with the structures. Flood plain management efforts of the community become more comprehensive and new buildings must be evaluated or floodproofed above certain flood levels. The floodproofing levels are shown on a Flood Insurance Rate Map (FIRM) which is derived from a detailed onsite engineering survey in the community. This map also shows flood elevation and outlines risk zones for insurance purposes.

When the FIRM is completed, the community qualifies for the Regular Program by adopting more comprehensive flood plain management measures. All new construction and any substantial improvements to existing structures must be elevated or floodproofed to the level of the base flood - the 100-year event.

Advantages

- Inexpensive to the insured at the subsidized rate.

- Indemnification is for any flood up to the limits of the policy.

Disadvantages

- Indemnification is limited both in magnitude and in type of damage.

- A deductible provision for each loss makes it somewhat less attractive for low damage flooding.

- Damages are not reduced.

5. Acquisition of Flood Plain Land - Public control over the flood plain may be obtained by purchasing the title or some lesser rights such as development or public access rights. Acquisition of the title is better suited for undeveloped or sparsely developed land in the flood plain. It is a very desirable means, however, of protecting and/or providing public access for environmental, wildlife protection, public open space and recreation or other purposes.

The means to do this is usually an easement granted or sold to the public agency. Ownership, use, access and occupancy may be retained by the owner but use is restricted by the terms of the easement. In experiences with

this form of land use control it has been found, in some cases, that the purchase of development rights may be almost as expensive as acquiring the full title because the owner's options have been reduced so much. Coupled with tax incentives, however, the technique has a great deal of promise as a floodplain management method.

Cost of acquisition in fee or easement depends upon the cost per acre and number of acres needed. Both items are highly variable and must be determined on a case-by-case basis. The number of acres needed depends upon the plan.

Advantages

- Provides control of land and its use with fee title.

- Provides controls of certain land uses with an easement, but without the burden of fee title.

Disadvantages

- Does not reduce existing damage.

- Requires land management and maintenance by the public owner.

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